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DIRECTORATE OF
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Intelligence Memorandum

*Rolling Thunder:
The 1967 Campaign Against LOC's*

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Copy No. 62

September 1967

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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence

INTELLIGENCE MEMORANDUM

Rolling Thunder: The 1967 Campaign Against LOC's

Summary

During 1967 the Rolling Thunder program changed significantly in its scope and intensity. North Vietnam's major industrial targets were neutralized, and new targets in the restricted areas around Hanoi and Haiphong and in the China border areas were attacked for the first time. Since June 1967 the program has put a renewed emphasis on the interdiction of lines of supply. The interdiction campaign has been enlarged to include intensive and repeated attacks against multiple targets on the vital lines of communication (LOC's) in the northern areas of North Vietnam.

Transport operations have been seriously disrupted, losses of transport equipment have increased sharply, and the costs and difficulties of maintaining traffic movements have multiplied. But as a result of countermeasures, the use of alternate routes, and foreign assistance, North Vietnam's logistic capabilities have not been reduced, and there is convincing evidence that the military and economic goods needed to support the war have continued to move.

Note: This memorandum was produced by CIA. It was prepared by the Office of Economic Research and was coordinated with the Office of Current Intelligence and the Special Assistant for Vietnamese Affairs; the estimates and conclusions represent the best judgment of the Directorate of Intelligence as of 29 September 1967.

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In the first eight months of 1967, more than 75,500 attack sorties were flown over North Vietnam, only about 6,700 less than were flown during all of 1966. Attack sorties flown over Route Packages V and VI in the North mounted from a low of 9 percent in February 1967 to a high of 37 percent in July 1967. More than three-fourths of the 9,300 tons of ordnance dropped on northern railroad targets in 1967 was delivered during the three-month period June through August. Successful attacks have been made against key bridges over the Canal des Rapides and the Paul Doumer Bridge over the Red River in the Hanoi area, and many other targets - primarily bridges and rail yards - have been struck along the rail lines leading north to China and Haiphong.

The main thrust of the air campaign during 1967, however, continues to be targeted against the logistics flow south of Hanoi. The recent extension to the key northern rail lines has not retarded significantly the flow of traffic and has not successfully entrapped transport equipment. A small number of locomotives were caught in the northern route packages, but more than 95 percent of the trucks and watercraft reported by pilots to be destroyed were located in Route Packages I-IV.

The attacks against logistics targets in the north involved higher aircraft loss rates. The overall combat loss rate for US aircraft was 3.0 per 1,000 attack sorties during 1967, an improvement over the higher rates of 6.7 and 3.5 during 1965 and 1966, respectively. During the attacks on the northern railroads alone, however, US forces suffered a combat loss rate during 1967 of 6.8 aircraft per 1,000 attack sorties.

North Vietnam has demonstrated its ability to counter the longstanding interdictions of through traffic on the Hanoi-Lao Cai line and the heavily pounded Hanoi-Vinh line. During the recent intensive attacks against the remaining rail lines in the northern area, the only additional disruptions

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to through service have been on the rail connections in the immediate Hanoi area. The resulting delays in traffic have probably not been serious.

The North Vietnamese transport system has emerged from more than 30 months of bombing with greater capacity and flexibility than it had when the Rolling Thunder program started. The inventory of freight cars has been maintained and its carrying capacity increased; the number of trucks has also increased despite the high rate of destruction.

The successful countering of the interdiction program is explained by several factors. The density of the logistics target system in North Vietnam is so low and its diversity so great that it is extremely difficult to neutralize. Many of the more important elements of the system are also located in densely populated and heavily defended areas. In addition, the North Vietnamese have an effective system of countermeasures, abetted and strengthened by large infusions of labor, material, and equipment from their Communist allies. The extensive implementation of contingency programs has given the target system a redundancy and cushion that preempted the effects of some of our most successful strikes. Finally the neutralization of North Vietnam's modern industry and the virtual cessation of exports have relieved the transport network of about 10 percent of the traffic it carried in 1966.

Although the air campaign destroys a large volume of supplies as they move southward, the requirements for supplies decrease further south and become extremely small at the end of the logistic funnel. It is clear that logistics problems have not placed a relevant ceiling on force structures or levels of combat.

Even a more intense interdiction campaign in the North would fail to reduce the flow of supplies sufficiently to restrict military operations.

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Prospects are dim that an air interdiction campaign against LOC's leading out of Haiphong alone could cut off the flow of seaborne imports and isolate Haiphong.

Political considerations aside, the combined interdiction of land and water routes, including the mining of the water approaches to the major ports and the bombing of ports and transshipment facilities, would be the most effective type of interdiction campaign. This program would increase the hardships imposed on North Vietnam and raise further the costs of its support of the war in the South. It would, however, not be able to cut off the flow of essential supplies and, by itself, would not be the determining factor in shaping Hanoi's outlook toward the war.

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I. Dimensions of the Air War

A. Air Operations

During 1967 the Rolling Thunder campaign became a new type of air war in the scope and intensity of its effort. North Vietnam's industrial sector and new targets -- primarily key transportation targets -- in hitherto sanctuary areas came under attack. During the past few months the intensified campaign has been characterized by tactical changes designed to disrupt more effectively the flow of war-supporting supplies. Concentrated, simultaneous, and multiple attacks have been carried out with increasing intensity against the key northern railroads. In the southern areas particularly the emphasis has shifted from attacks on fixed lines of communication (LOC) targets to transport equipment and supplies.

During the period January-August 1967, more than 75,500 attack sorties were flown against targets in North Vietnam -- only about 6,700 less than were flown during all of 1966 and nearly three times the number flown in 1965. As a result of an increase in the average ordnance load per sortie, nearly as much ordnance -- 147,000 tons* -- was delivered in the first eight months of 1967 as the total delivered during 1966 and 1965. The loss rate for aircraft downed by hostile action has decreased from 6.7 per 1,000 attack sorties in 1965 to 3.5 in 1966 and 3.0 during January-August 1967. Total losses of aircraft from hostile action during the three years amount to 682. The following tabulation gives a comparison of sorties, ordnance, and losses during 1965, 1966, and January-August 1967:

* Data on ordnance are given in short tons; data on traffic and trade are given in metric tons.

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	<u>Attack Sorties</u>	<u>Tons of Ordnance Delivered</u>	<u>Tons per Attack Sortie</u>	<u>Losses of US Aircraft to Hostile Action</u>	<u>Losses per 1,000 Attack Sorties</u>
1965	25,880	34,300	1.3	173	6.7
1966	82,170	128,590	1.6	284	3.5
Jan-Aug 1967	75,510	147,030	1.9	225	3.0
Total	<u>183,560</u>	<u>309,920</u>	<u>1.7 a/</u>	<u>682 b/</u>	<u>3.7 a/</u>

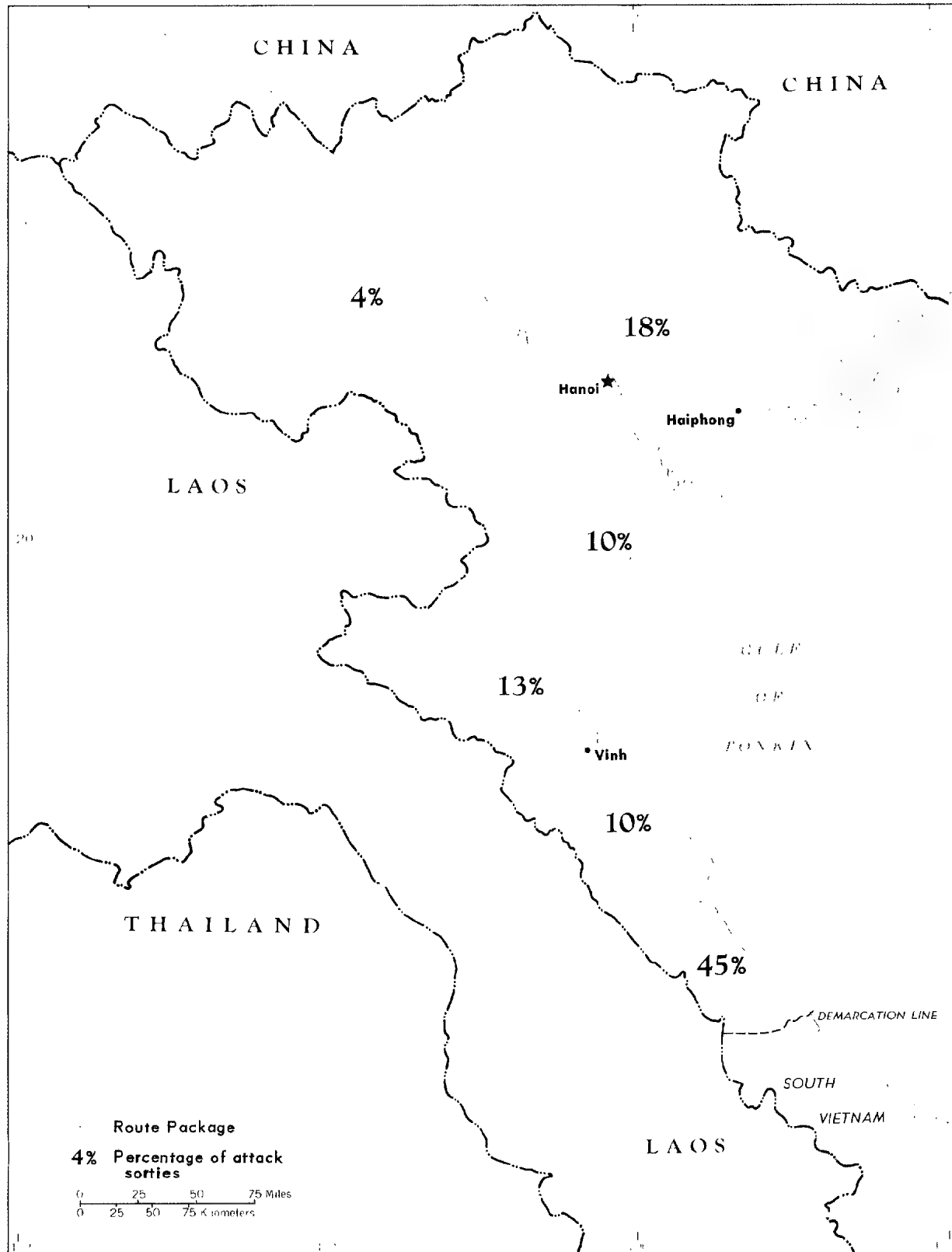
a. Average.

b. An additional 81 aircraft were operational losses. The total of US losses from all causes, therefore, is 763.

During 1967 the Rolling Thunder program has remained primarily an interdiction campaign against the LOC's in the Panhandle. About 78 percent of all attack sorties flown from January through August 1967 were against targets in Route Packages I-IV (see Figure 1). Since March 1967, however, an increasing share of attack sorties has been directed against targets in Route Packages V and VI. Thus, although only about 13 percent of total attack sorties were flown over Route Packages V and VI in 1966 and the early months of 1967, this share rose to 37 percent in July 1967. The following tabulation gives shares of attack sorties by geographic area in North Vietnam during 1966 and 1967:

	<u>Percent</u>		
	<u>Route Packages I-IV</u>	<u>Route Packages V-VI</u>	<u>Total</u>
1966	87	13	100
1967	78	22	100
January	86	14	100
February	91	9	100
March	89	11	100
April	81	19	100
May	82	18	100
June	77	23	100
July	63	37	100
August	73	27	100

Rolling Thunder Attack Sorties by Route Package, January-August 1967



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A significant share of the attacks against targets in Route Packages V and VI has been against railroads. During the period January-August 1967, about 4,530 attack sorties -- 28 percent of the 16,220 attack sorties flown in Route Packages V and VI -- delivered more than 9,300 tons of ordnance against the six railroad lines (see the tabulation below) located wholly north of the 20th Parallel (see Figure 2). More than three-fourths of this ordnance was delivered in the three-month period of June-August. The greatest weight of attack against northern lines was on the key northeast line leading from Yen Vien to Dong Dang.

During the eight-month period, 5,590 attack sorties delivered about 11,900 tons of ordnance against the railroad running south from Hanoi through Route Package IV to Vinh. This amounted to 56 percent of total ordnance delivered against railroads in North Vietnam. The changed focus of the campaign against railroads is apparent in the fact that while the Hanoi-Vinh line withstood almost 80 percent of the weight of attack from January through May 1967, it took only about 35 percent of the attack during June through August. The following tabulation gives tons and shares of ordnance against each railroad by time period.*

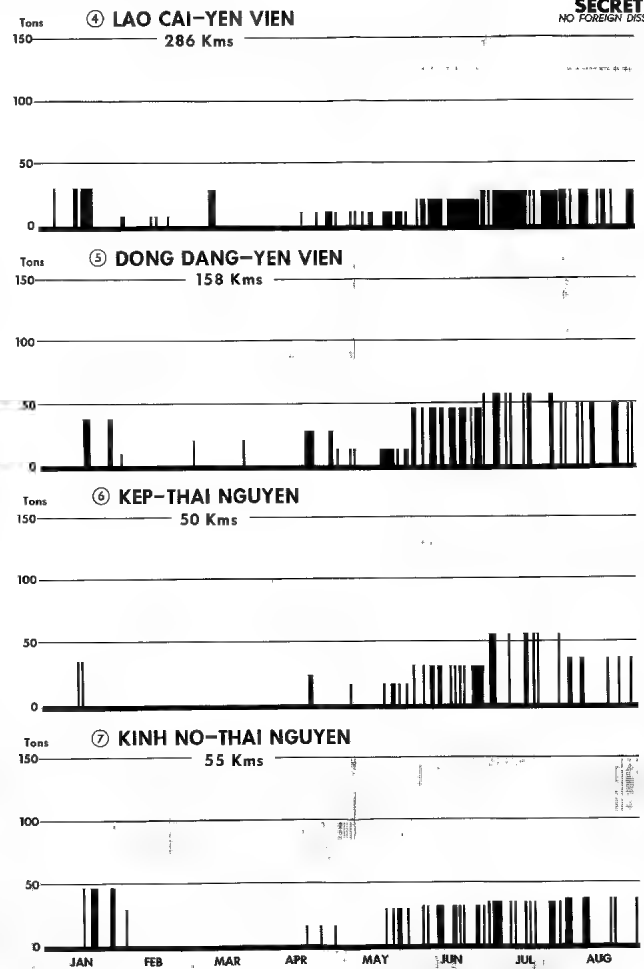
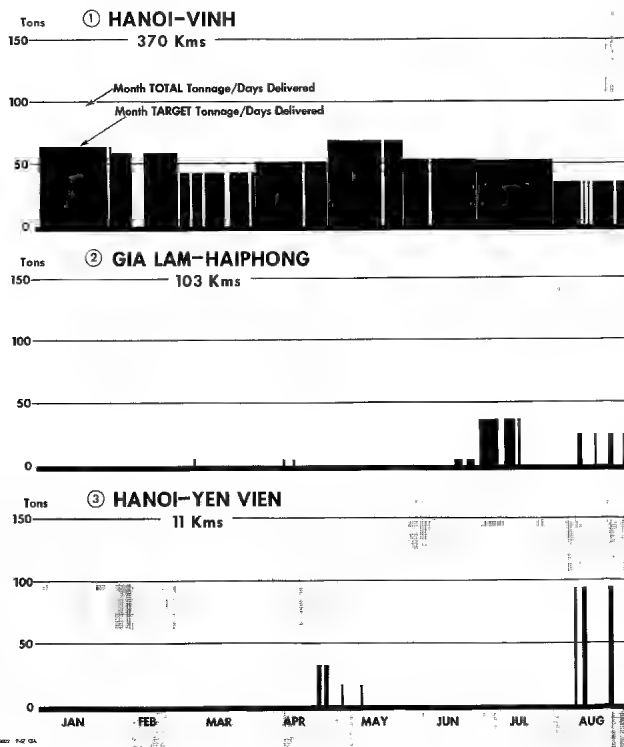
** Six lines radiate from Hanoi. Traffic from Hanoi to Lao Cai, Dong Dang, and Thai Nguyen moves over the 11-kilometer segment to the Yen Vien yards. This segment is sometimes treated as part of the Hanoi-Dong Dang line.*

	<u>January-May</u>		<u>June-August</u>		<u>Total</u>	
	<u>Tons</u>	<u>Per-</u> <u>cent</u>	<u>Tons</u>	<u>Per-</u> <u>cent</u>	<u>Tons</u>	<u>Per-</u> <u>cent</u>
Hanoi - Yen Vien	164	26	472	74	636	100
Yen Vien - Lao Cai	577	26	1,636	74	2,213	100
Yen Vien - Dong Dang	564	22	1,983	78	2,547	100
Gia Lam - Haiphong	16	2	729	98	745	100
Kinh No - Thai Nguyen	503	29	1,242	71	1,745	100
Thai Nguyen - Kep	218	15	1,220	85	1,438	100
Total on lines wholly located north of the 20th Parallel	<u>2,042</u>	22	<u>7,282</u>	78	<u>9,324</u>	100
Hanoi-Vinh	<u>7,744</u>	65	<u>4,113</u>	35	<u>11,857</u>	100
Total on all rail- roads	<u>9,786</u>	46	<u>11,395</u>	54	<u>21,181</u>	100

During the period January-May, attacks against railroads in the northern route packages were carried out during 57 days -- about 38 percent of the 151-day period. The intensity of the latest campaign against these railroads is indicated by an increase in the share of days they were under attack to almost 85 percent of the June-August period. Similarly, the share of days that the Hanoi-Vinh railroad was attacked rose from 89 percent during January-May to about 95 percent during June-August. The following tabulation gives the share of each period during which attacks against railroads were carried out.

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NORTH VIETNAM **Continuity and Intensity of** **Attacks on Railroads**



	Percent	
	<u>January-May</u>	<u>June-August</u>
Hanoi - Yen Vien	4.0	5.4
Yen Vien - Lao Cai	24.5	68.5
Yen Vien - Dong Dang	17.2	43.5
Gia Lam - Haiphong	2.0	28.3
Kinh No - Thai Nguyen	9.9	39.1
Thai Nguyen - Kep	6.6	33.7
Railroads north of the 20th Parallel	37.7	84.8
Hanoi-Vinh	88.7	94.6

The campaign against railroads has accounted for 13 percent of the Rolling Thunder attack sorties flown during January-August 1967. Aircraft losses sustained in these attacks totaled 41, or 18 percent of total US combat losses during January-August 1967. A share amounting to 68 percent -- 28 aircraft -- was downed in June-August alone. This disproportionate loss rate reflects the higher risk to aircraft attacking railroads in heavily defended areas.

Thus, while the overall combat loss over North Vietnam during these eight months was 3.0 aircraft per 1,000 attack sorties, the campaign against railroads resulted in a combat loss rate of 4.0 aircraft. During the June-August period, attacks against railroads resulted in a loss rate of 4.7 aircraft. The loss rate for attacks against northern rail lines alone during this period was even higher -- 6.3 aircraft per 1,000 sorties -- although it was down somewhat from the loss rate of 6.9 for all attacks in 1967 against the northern rail lines.

The scale of attack against North Vietnam's railroads during 1967 is indicated by a comparison with the number of attacks against all other JCS-targeted facilities. These targets, which include electric powerplants, manufacturing and explosives plants, petroleum storage facilities, airfields, barracks, supply and ammunition depots, and radar

sites, have been struck during 1965, 1966, and January-August 1967 by about 9,700 attack sorties delivering more than 15,700 tons of ordnance. Attacks against railroads during 1967 alone amounted to more than 10,100 attack sorties delivering almost 21,200 tons of ordnance.

B. The Effects of the Bombing - Economic and Military Damage

Although the Rolling Thunder program is preponderantly an interdiction effort against transportation routes and other logistic targets, attacks against major industrial plants and important military targets have given new dimensions to the air war.

The 1967 campaign against important industrial facilities has brought North Vietnam's small modern industry to a standstill. About 80 percent of the central electric power generating capacity is currently out of operation. All the central generating plants in the main Hanoi-Haiphong network, with the exception of the main Hanoi plant itself, have been out of service since early June.

The country's only modern cement plant -- at Haiphong -- ceased production in April 1967 because of bomb damage and the loss of its electric power supply. The country's only metallurgical plant -- at Thai Nguyen -- which produced pig iron for export and fabricated products from imported steel has ceased production for the same reasons. The only explosives plant has been out of operation for two years, and the production of apatite and coal, both previously exported in quantity, has been drastically reduced. One of the country's two textile plants has been heavily damaged, production in the small fertilizer and chemical industry has been curtailed, and the production of paper has been reduced by 80 percent.

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The damage inflicted to North Vietnamese industry by the bombing undoubtedly has crushed North Vietnam's immediate hopes for continued economic growth. Modern industry, however, plays only a small and limited role in North Vietnam's ability to continue the war. By any measure, even by the standards of a less developed country, North Vietnam's industry has offered few lucrative targets in terms of military significance.

The damage inflicted on military targets also has had little significant impact on North Vietnam's overall military capability. Attacks against these targets, however, have disrupted normal military activities, have caused the abandonment of many facilities such as barracks and supply depots, and have forced widespread dispersal of equipment and forces. Despite these disruptions, the North Vietnamese have been able to strengthen and improve the capability of many military systems. During the past three years, Hanoi has developed its air defense from a rudimentary state to a complex, sophisticated system and has increased its troop strength from 240,000 to 385,000 men.

The cumulative effects of the bombing have caused numerous management and logistical problems for the North Vietnamese and have raised the cost of Hanoi's support of the insurgency in South Vietnam. Up to 600,000 persons are engaged in full-time or part-time work defending against or countering the effects of the bombing. The movement of men and supplies has become more difficult and time consuming, and a substantial volume of war and war-supporting material has been destroyed in transit.

The increased intensity of the air war in 1967, particularly during the past three months, is shown in the tabulation below, which summarizes the value of damage to economic and military targets. The estimated cost of damage inflicted on economic and military targets during the first eight months of 1967 was about 40 percent greater than the damage inflicted in all of 1966. Damage to economic targets in the last three months, even with bomb damage assessment incomplete, was about equal to the damage inflicted in the five-month period of January through May.

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<u>Type of Target</u>	<u>Million US \$</u>				
	<u>1967</u>				
	<u>1965</u>	<u>1966</u>	<u>Jan-May</u>	<u>Jun-Aug</u>	<u>Jan-Aug</u>
Economic	36.2	93.3	53.4	53.7	107.1
Military	32.5	19.1	31.0	20.3	51.3
Total	<u>68.7</u>	<u>112.4</u>	<u>84.4</u>	<u>74.0</u>	<u>158.4</u>

Attacks against LOC's and transport targets in 1967 have already inflicted about the same damage as was inflicted in all of 1966. The cost of damage by type of target is as follows:

<u>Type of Target</u>	<u>Million US \$</u>				
	<u>1967</u>				
	<u>1965</u>	<u>1966</u>	<u>Jan-May</u>	<u>Jun-Aug</u>	<u>Jan-Aug</u>
Railroad/highway bridges	11.1	11.2	3.1	3.5	6.6
Transportation equipment	5.9	29.8	11.4	18.6	30.0
Railroad yards	0.1	1.2	3.9	0.6	4.5
Maritime ports	0.7	0.8	Negl.	Negl.	Negl.
Miscellaneous armed reconnaissance	N.A.	1.2	0.3	0.6	0.9
Total	<u>17.8</u>	<u>44.2</u>	<u>18.7</u>	<u>23.3</u>	<u>42.0</u>

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II. North Vietnam's Transport System

A. Capability and Performance Before Rolling Thunder

The transportation system of North Vietnam, in ruins at the end of the Indo-China conflict in 1954, had been largely restored by late 1964. Except for a branch rail line to Thai Nguyen and some roads in the frontier areas, no major extensions were made to the system inherited from the French. Five single-track meter-gauge rail lines totaling about 965 kilometers radiated from Hanoi. The Hanoi - Dong Dang line, the major line to China, connected with the standard-gauge network of Communist China at a transloading station at P'ing-hsiang in Kwangsi Province. The Hanoi - Lao Cai line connected with the Chinese meter-gauge line to K'un-ming in Yunnan Province.

The highway system also radiated from Hanoi and consisted of about 10,000 kilometers of roads. Five roads connected with China, and several strategically important roads led west to Laos or south to the Demilitarized Zone. The inland waterway network consisted of about 5,400 kilometers of navigable rivers and canals. Coastal shipping used North Vietnam's only major seaport at Haiphong, two secondary ports at Cam Pha and Hon Gai, and ten minor ports, including one at Ben Thuy.

Before the bombing, motor transport served primarily as a short-haul feeder system to the railroads, provided access to remote regions, and served to support Communist military aggression in Laos and South Vietnam. Inland water transport was concentrated primarily in the Red River Delta, where it served all of North Vietnam's several industrial centers. However, the waterways also provided access to the upper reaches of the Red River and the Song Cau. Inland and coastal shipping was used heavily to move agricultural, forest, and mineral products.

Total traffic on the transportation system in 1964 reached about 1.75 billion ton-kilometers (tkm) and 18.7 million tons carried as follows:

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<u>Carrier</u>	<u>Million Ton-kilometers</u>	<u>Percent of Total</u>	<u>Million Metric Tons</u>	<u>Percent of Total</u>
Railroads	926.8	53	4.13	22
Highways	178.7	10	7.18	38
Inland waterways	490.5	28	7.01	38
Coastal waterways	155.9	9	0.37	2
Total	<u>1,751.9</u>	<u>100</u>	<u>18.69</u>	<u>100</u>

Despite significant increases in traffic between 1960 and 1964, the rudimentary North Vietnamese transportation network was not highly utilized in 1964. The tonnage moved by rail in 1964 was only slightly greater than one-third of line capacity. The total freight moved by all modes of transport in North Vietnam during 1964 was about equivalent to the traffic moved by regulated carriers alone in the United States in a period of less than eight hours. Additional perspective of the rudimentary nature of the North Vietnamese transportation system can be gained by comparing it with Thailand. The average daily freight train density in North Vietnam in 1964 was 21 trains, compared with 132 in Thailand. The volume carried by all modes totaled 19 million tons in North Vietnam and 146 million tons in Thailand. North Vietnam had 6,000 civilian trucks and Thailand, 73,000.

B. Network and Inventory Since 1964

1. Railroads

The flexibility and capacity of the railroad network has been improved with the help of Chinese construction troops since the bombing began. Many bridges and yards throughout the system have been bypassed by the construction of alternate bridges and short sections of line (see Figure 3).^{*} A rail line with a rail ferry for the river crossing was constructed as a bypass to the Doumer Bridge before the bridge was interdicted. The most important additions include the construction of a 50-kilometer standard-gauge line from Kep to Thai

^{*} For a discussion of bridge construction and other countermeasures in North Vietnam, see VI.

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Figure 3



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Nguyen and the installation of a third rail on the lines from the yards north of the Canal des Rapides to Dong Dang via Thai Nguyen to accommodate standard-gauge equipment.* The Kep - Thai Nguyen line forms part of an alternate route between Kep and Yen Vien. Installation of the third rail makes possible the use of Chinese standard-gauge equipment on this route and obviates transloading at P'ing-hsiang.

The inventory and capacity of the rolling stock available to the North Vietnamese have increased since the beginning of the bombing despite heavy losses. Compared with an estimate of about 2,000 freight cars in North Vietnam at the end of 1964, photography of July 1967 revealed an estimated 2,000 to 2,300 freight cars. Considering that at least a portion of these cars are standard-gauge cars, with double the carrying capacity of meter-gauge cars, it is certain that the capacity of the inventory has increased significantly.**

2. Highways

The highway network also has been extended since the beginning of the bombing, with emphasis on increasing its flexibility. The length of the road network has been increased from about 9,000 to 10,000 kilometers of roads at the end of 1964 to between 11,000 and 13,000 kilometers at present. Instead of five motorable border connections to China there are now at least eight. Instead of one all-weather route into Laos there are now three. The general quality of the highways and the capacity of some individual routes have deteriorated as a result of the bombing and increased traffic loads. However, the ability of the system to handle increased

* Also referred to as "dual gauge" in this memorandum. This term refers to three rails, making possible the use of both meter-gauge and standard-gauge rolling stock, and is not to be confused with "double tracking" -- two separate tracks with a total of four rails.
 ** For an analysis of railroad operations in North Vietnam as obtained from aerial photography, see the Appendix.

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traffic has not been reduced, because of the many new routes and bypasses that have been built to avoid restricting sections.

Highway transport continues to serve mainly as a short-haul feeder service to the railroads, but trucks are being used increasingly to handle traffic problems resulting from rail interdiction and to keep supplies moving to the military forces in the outlying areas to the south of the main networks. The heaviest movement of traffic, however, continues to be centered around the two main cities of Hanoi and Haiphong and other population centers in the Delta.

Imports of trucks were sufficient to increase the inventory from about 9,000 vehicles at the end of 1964 to between 11,000 and 12,000 by the end of 1965. The inventory has remained at about this level. It appears, moreover, that trucks are stored in quantity at P'ing-hsiang to be drawn on in response to fluctuating traffic needs and losses.

3. Waterways

The inland water network remains much the same as it was in 1964, except for dredging and other improvements that have increased the navigability on the upper portions of the Red and Black Rivers and the canal system near Vinh. Work on the system in the past two years has been sufficient to enable water transport to be used effectively in overcoming attacks on other modes and to carry an increasing share of the total traffic. No reliable estimates of the inventory of watercraft in North Vietnam are available. Although destruction of watercraft has been heavy, there is no indication that shortages have been serious. Imports have continued throughout the period and watercraft are produced domestically.

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III. Effects of Attacks on the Transport System

A. General

The intensified interdiction campaign against LOC's and transport targets in the northern areas of North Vietnam has certainly compounded Hanoi's logistic problems and exacted a significantly higher price in terms of damage to facilities and equipment. Despite these achievements, North Vietnam has sustained its capability to keep traffic moving. Through service has been maintained on all major rail lines with the exception of the rail connections in the immediate Hanoi area and the heavily pounded Hanoi-Vinh line.* The system is flexible and resilient, however, and a variety of alternative routes and previously constructed bypasses have kept the flow of goods moving in those few cases where a sustained interdiction has resulted from air attacks. Although losses of transport equipment have increased sharply during the past few months, they have not been sufficient to reduce inventories. The inventory of freight cars has been maintained and its carrying capacity has increased. If transport equipment continues to be destroyed or damaged at the present higher rate, however, North Vietnam's Communist allies will have to step up significantly the level of their deliveries of this equipment.

B. Hanoi Area (see Figures 4 and 5)

The transportation network in the immediate Hanoi area - from the center of Hanoi to the Yen Vien classification yard, 11 kilometers across the Red River - is a key connection for all traffic moving between Hanoi and China, south to Vinh, or east to Haiphong. This section contains two of North Vietnam's most important railroad/highway bridges and two of its largest railroad classification yards, Yen Vien and Gia Lam. Both yards have been struck occasionally, but operations have not been seriously impeded. All rail and highway

* Through service on the Hanoi - Lao Cai line has not been possible since the bridge at Viet Tri was interdicted in June 1966, but the line carries only a small volume of traffic.

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traffic from Hanoi to Haiphong, Dong Dang, Lao Cai, and Thai Nguyen must cross the mile-long Hanoi Railroad/Highway (Doumer) Bridge over the Red River. In addition, traffic from areas north of the Canal des Rapides must use the Hanoi Railroad/Highway Bridge over the Canal des Rapides to reach the yard at Gia Lam and the Doumer Bridge. The rail line from Haiphong to Hanoi joins the rail line into Hanoi at Gia Lam, south of the Canal des Rapides bridge.

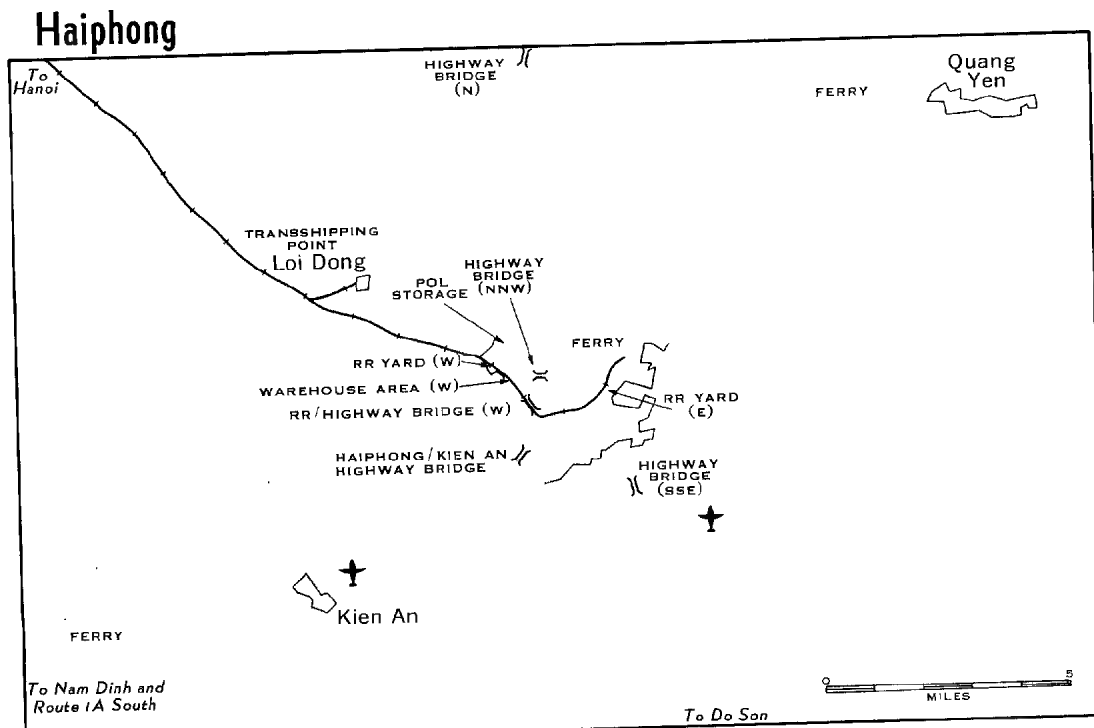
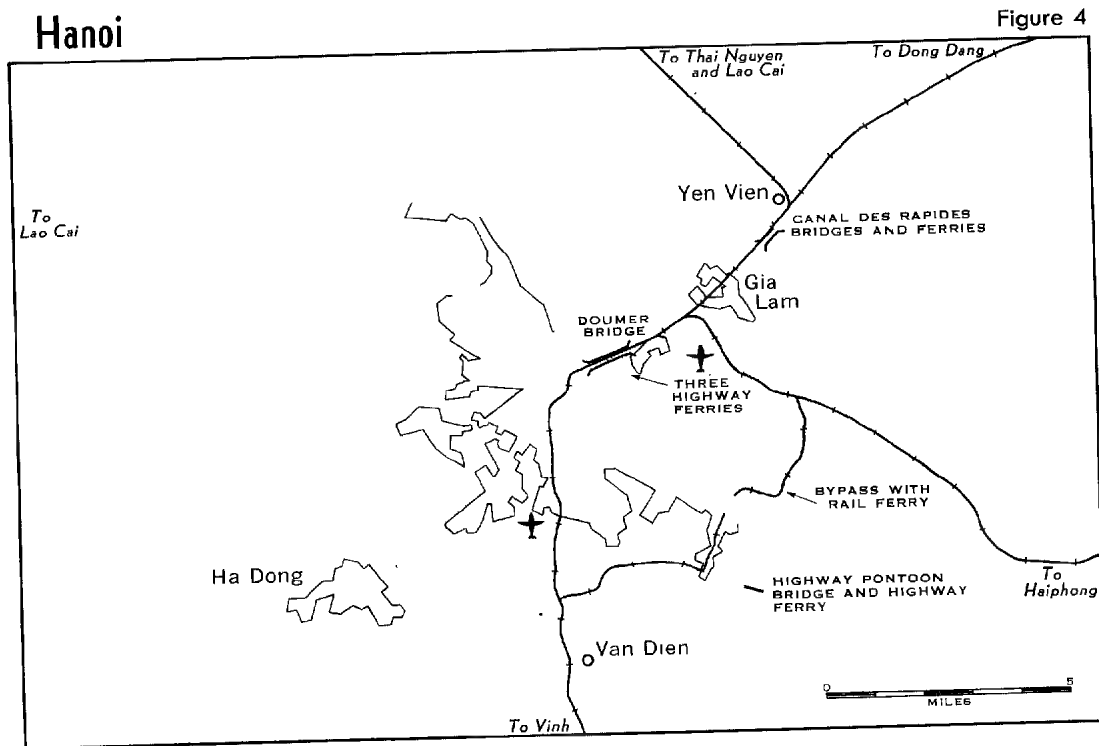
When the vital Doumer Bridge was interdicted on 11 August, through rail and highway traffic between Hanoi and Haiphong, and Hanoi and points north of the Canal des Rapides was effectively disrupted. After this date, traffic across the Red River was limited to the use of the following bypasses, all of which were available before the attacks started:

- (1) A highway ferry 800 feet south of the bridge;
- (2) Highway ferries located 2,500 and 4,500 feet, respectively, south of the bridge;
- (3) A highway pontoon bridge located 10 kilometers south of the main bridge;
- (4) A highway ferry located next to this pontoon bridge, and
- (5) A series of three pairs of rail ferry slips located 7 kilometers south of the bridge on spurs which connect the Hanoi-Haiphong and Hanoi-Vinh lines. All of the slips may be serviceable in lower water, but during the present highwater season, only one slip on each

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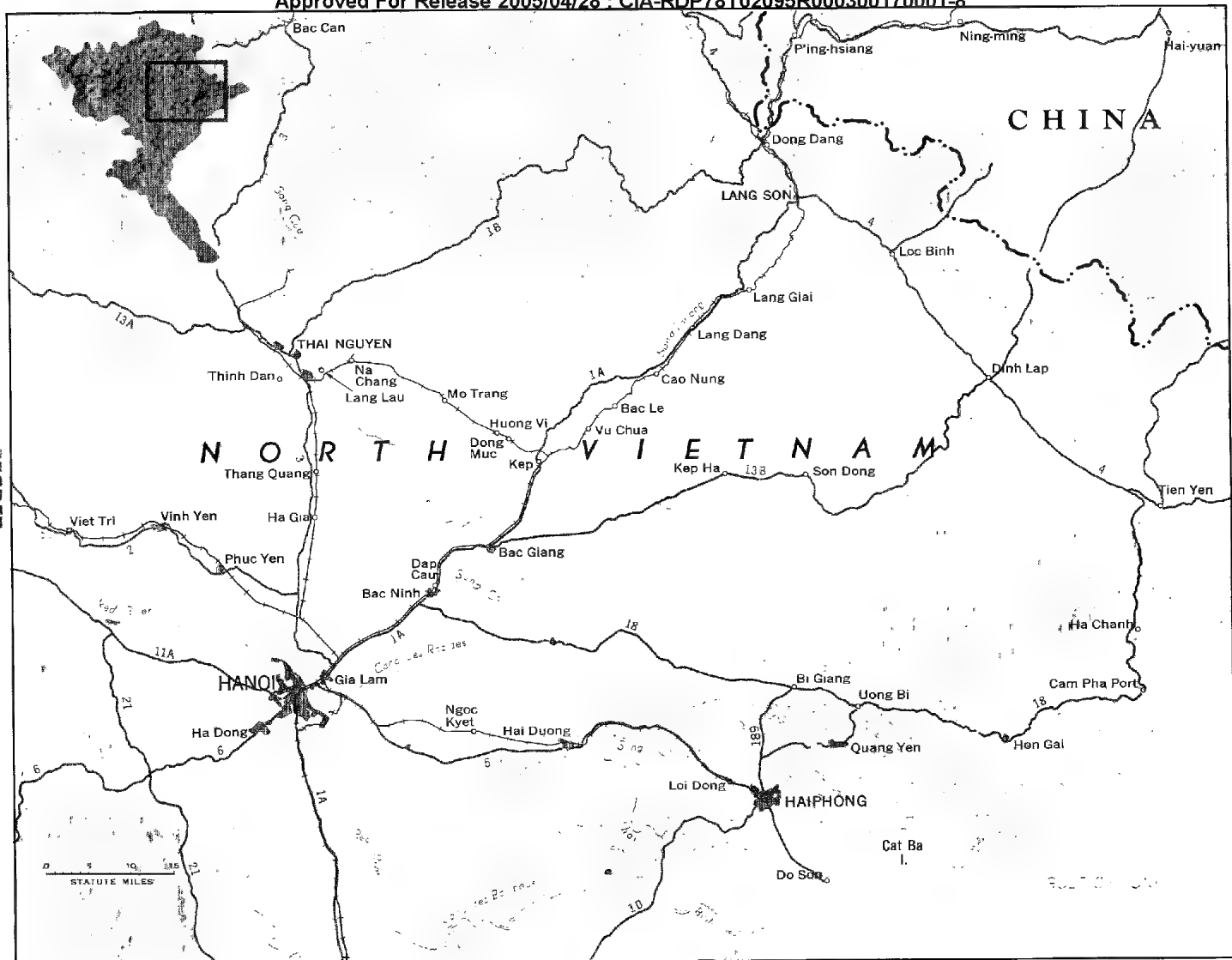
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bank can be used. Photography has shown that MK-36 magnetic-influence bombs, dropped on the rail ferry area, interdicted a low water ferry slip, but loaded ferries are operating between the high water slips.

If all the highway and rail bypasses across the Red River were in operation at one time, an estimated 5,000 to 5,500 tons each way per day could be moved, of which about 1,300 tons could be moved by the rail ferries.

On 12 August the main bridge over the Canal des Rapides was damaged, but the flow of traffic from points north was not disrupted, because a previously constructed railroad bypass bridge equal in capacity to the main bridge was available. On 22 August, however, the bypass was also interdicted, thus disrupting the flow of traffic to the Red River and Haiphong from Dong Dang, Thai Nguyen, and Lao Cai. Traffic across the Canal des Rapides was forced temporarily to utilize the following bypasses. Photography of 17 September shows the main bridge serviceable for rail and highway traffic.

- (1) A highway ferry located 6,800 feet west of the main bridge;
- (2) A highway pontoon bridge 6,850 feet west of the main bridge; and
- (3) A rail ferry site 3,000 feet east of the original bridge.

These bypasses can probably accommodate traffic of about 5,000 to 5,500 tons each way per day, of which about 1,800 tons could be moved by the rail ferry. A second rail ferry and a highway cable bridge are under construction near the original bridge.

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The rail ferry bypass over the Red River serving Hanoi and areas south probably has a capacity of about 1,300 tons each way per day. This capacity is probably being utilized principally to handle traffic from Haiphong. Rail traffic moving south into the Hanoi and Haiphong areas on the Dong Dang line could be accommodated by the rail ferry bypass at the Canal des Rapides. To enter Hanoi by rail, however, trains from Dong Dang would have to cross the Canal des Rapides, enter Gia Lam, head east on the Haiphong line to the rail ferry bypass line across the Red River, ferry across the Red River, and enter Hanoi from the south. This routing would involve the use of two rail ferries and would also interfere with traffic from Haiphong which must use the Red River rail bypass. Thus, it is probable that traffic from Dong Dang is transshipped at Gia Lam and the goods moved all the way into Hanoi by truck. The several highway bypasses on the Red River and the inland waterway system in the Delta area are more than adequate to handle the diversions of traffic imposed by the interdiction of rail lines in the Hanoi area.

Photography of 17 September indicates that repairs on the Red River bridges are under way. Cables and decking were noted across the damaged 125-foot span, and the bridge may now be serviceable for limited vehicular use. At the Canal des Rapides, the two damaged spans on the original bridge have been repaired and are now serviceable for rail and truck traffic. The restoration of these vital bridges should greatly facilitate the movement of goods to the Hanoi area and south.

C. LOC's North of Hanoi

1. The Dong Dang Line and Highway Routes to the Northeast

The most important rail connection between Hanoi and Communist China is the line extending northeast from Yen Vien, across the Red River from Hanoi, to Dong Dang. The rail bridges at Bac Giang and Dap Cau and the key rail yards at Kep, Cao Nung, and Bac Giang were attacked in June. In July, attacks continued against these targets and against the yards at Vu Chua and Bac Le, but less intensively. During August, several new targets in the buffer zone along the Chinese border were struck in addition to the others under attack since June. These new targets included the railroad/highway bridge and its bypass at Lang Son, the railroad/highway bridge at Lang Dang, and the rail yards at Lang Dang and Lang Giai.

These strikes were not effective in stopping through service, mainly because each bridge had one or more bypass bridges available. At Dap Cau the original bridge was serviceable during much of the period and a railroad bypass bridge and four highway bypasses were available. At Bac Giang the main bridge was also serviceable most of the time and a rail bypass bridge and rail ferry were available. The attacks against the railroad bridges at Lang Son in August destroyed the original bridge and damaged a bypass. A second rail bypass was available, however, and a probable highway pontoon bypass was noted soon after the strike. The original bridge at Lang Dang remained serviceable throughout August. The railroad bypass bridges on this line are well constructed and capable of supporting nearly the same volume of traffic as the original bridges. As the Dap Cau and Bac Giang bridges are south of Kep, they can be bypassed by using the Kep to Thai Nguyen route.

Photography taken throughout the period indicates that several yards, including Kep, Vu Chua,

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Cao Nung, and Bac Giang, were sometimes unserviceable for through rail service after they were struck but had at least one through track open for traffic within a short time. Attacks against other rail yards did not disrupt through traffic. The yard at Vu Chua, for example, was struck on 19 and 20 July, and photography of 20 July showed two of five tracks available for through service. Photography showed one through track serviceable after a strike on 28 August.

The Dong Dang line is estimated to have been operational for through traffic for nearly 20 days during August, and shuttle traffic could have moved over the line between the few points of interdiction throughout the month. The normal capacity of this line is estimated to be 3,000 tons each way per day as a meter-gauge system and nearly double this amount on the dual-gauge portion of the line. The actual volume of traffic currently moved on the line is estimated to be about 800 tons per day southward over most sections. Northbound traffic is much lighter.

Highway Route 1A generally runs parallel to the Dong Dang line and can serve as an alternate route to the rail line. Two other highways from Mong Cai and Cao Bang could also be used as alternate routes from Kwangsi Province to the Hanoi area. These three routes together are estimated to have an uninterdicted capacity of 2,700 tons each way per day in the dry season and 650 tons in the rainy season. Although we are unable to estimate the reduction of daily capacity on any one of these routes, the countermeasures observed would indicate that no significant or sustained reduction has been made. Moreover, there is no evidence that these roads are being used at even their wet-season capacity. Traffic consists mainly of local economic and military traffic, except for that shifted temporarily from the rail line to bypass rail interdictions.

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2. Thai Nguyen Lines

The Thai Nguyen lines extend east to Kep, on the Dong Dang line, and south from Thai Nguyen to Hanoi. The Kep - Thai Nguyen segment is a recently constructed standard-gauge line and the Hanoi - Thai Nguyen route has been converted to dual gauge. These lines can serve as an alternate route for the portion of the Dong Dang line from Kep to Hanoi. The rail line from Thai Nguyen to Hanoi has a comparatively good quality highway paralleling it, with an uninterrupted dry season/wet season capacity of about 1,200/240 tons each way per day. The Kep - Thai Nguyen line, however, is supplemented only by low-capacity secondary roads.

The Thai Nguyen yard was heavily attacked several times as were yards at Na Chang, Tinh Dau, Thang Quang, and the important bridges at Ha Gia and Lang Lau. These attacks have not meaningfully restricted traffic on the Hanoi - Thai Nguyen line. Photography indicates that the Ha Gia bridge was serviceable until 4 August, when one span was dropped. Photography of 11 August, however, shows this bridge restored to service. A rail-to-water transshipment point, a highway bridge, and three fords were available to accommodate traffic during the few days the bridge was out. At Lang Lau, either the original or a bypass bridge has been available for rail traffic during June-August. A comparison of photography reveals that the two destroyed spans of the main bridge were completely repaired in not more than 19 days.

The rail line at Thai Nguyen was heavily damaged on several occasions during June-August, but photography indicates that at least one through track was probably serviceable throughout the period. The other yards attacked were unserviceable for short periods of time but were able to provide through service within 24 hours after each attack.

The Kep - Thai Nguyen line was also heavily attacked. The rail yards at Mo Trang

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and Huong Vi and the rail bridges at Mo Trang and Dong Muc were all struck several times. These attacks did not disrupt through service at the bridges. Photography shows the bridge at Mo Trang serviceable throughout the three months. The Dong Muc bridge, or its rail bypass bridge, apparently was also serviceable throughout the period. The two yards struck were serviceable for through service most of the period.

3. Lao Cai Line and Other Transport Routes to the Northwest

North Vietnam's other rail connection to Communist China extends northwest from Hanoi to Lao Cai on the Chinese border. Targets struck during the intensified bombing period included the rail yards at Viet Tri, Yen Bai, Phu Duc, Phu Tho, and Som Tra and the rail bridge at Chien Ung. The Lang Con railroad bridge in the buffer zone along the Chinese border was struck for the first time in August.

The through capacity of the Lao Cai line was reduced from 3,000 tons a day to about 700 tons in June 1966, when the bridge at Viet Tri was destroyed. A rail ferry has been utilized at the site of the bridge and has been more than adequate to carry present levels of traffic. Other bridges on this line span small streams so that repairs can be easily effected and bypass bridges, of which several have been noted in recent photography, readily constructed. One or more yards were closed to through traffic from time to time during June-August but seldom for more than 24 hours.

The highway network between Hanoi and the Lao Cai area has been considerably extended and improved during the past two years. The two principal routes, one on each side of the Red River, could carry about 1,600 tons each way per day during the dry season and 300 tons during the wet season, but they are only used now for local and feeder traffic. Highway traffic around the destroyed bridge at Viet Tri is carried by ferries

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and a pontoon bridge. Other highway bridges attacked on these routes have not been significant structures and have been quickly repaired or bypassed.

The Red River provides additional capacity of at least 2,700 tons from June through October and 900 tons during the dry season. During high water, craft drawing up to 7 feet can reach Lao Cai. Traffic in the upper reaches is relatively light and consists primarily of agricultural and forest products and some construction materials.

D. LOC's from Haiphong

Traffic into and out of Haiphong moves over an effective, flexible network, which includes the main rail line, three major and numerous secondary roads, two major inland water systems, many minor waterways, and the coastal water routes. Only the major routes have been included on Figures 4 and 5.

1. The Hanoi-Haiphong Railroad Line

The 103-kilometer railroad between Hanoi and Haiphong carries a heavy volume of international traffic. Only a few ineffective strikes were made on this line until the last week in June, when the Hai Duong Railroad/Highway Bridge East and one rail bypass were hit several times and rendered unserviceable. The July and August attacks were directed against the Hai Duong Railroad/Highway Bridge and its bypasses, the Hai Duong Railroad/Highway Bridge East and its bypasses, the railroad/highway bridge, the bypass, the rail yard at Ngoc Kuyet, and the rail yard at Hai Duong. In addition, during the first two weeks in September, several strikes were made against bridges in the previously restricted zone around Haiphong. Photography of 17 September shows the rail bridge in the restricted zone to be serviceable.

Attacks against bridges on the line east of Gia Lam interrupted through rail service

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only temporarily, if at all. The Hai Duong Railroad/Highway Bridge was successfully interdicted in early July and remained unserviceable through August. However, a railroad pontoon bridge, probably able to support the weight of a regular train, was available throughout the period, but apparently was not in use during the daytime. A rail bypass bridge is also under construction at this site. In addition, five highway bypasses (three ferries with a total capacity of 500 to 600 tons and two pontoon bridges with a combined capacity of 5,000 tons) are available.

Photography indicates that the Hai Duong Railroad/Highway Bridge East was unserviceable for only short periods during the three months. Bypasses at this bridge include a probable rail ferry bypass (1,000 tons each way per day), three highway ferries (about 650 tons each way per day), and one highway pontoon bridge (2,700 tons each way per day). The railroad/highway bridge at Ngoc Kyet was not interdicted, but its rail bypass bridge was badly damaged. Attacks against rail yards and sidings interrupted through rail service only temporarily. The effectiveness of the MK-36 magnetic-influence bombs used to seed the waterways and ferry site at the two railroad/highway bridges at Hai Duong cannot be judged.

The intensified air campaign during June, July, and August did not effectively disrupt rail service between Hanoi and Haiphong. Photography shows changes in the composition and numbers of rolling stock in the yard in Haiphong and trains on the line. The restricting facility for through rail traffic was apparently the pontoon rail ferry at the Hai Duong Bridge East. This ferry probably restricted through rail traffic to 1,000 tons each way per day. However, by using the highway bypasses at this point the uninterdicted capacity of the line - 4,000 to 5,000 tons each way per day - could have been achieved.

About 2,900 tons per day of import traffic could normally have been expected to move

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over the line in August. This tonnage would require about 200 freight cars, or 10 trains, per day. Photography of 20 June and 21 August revealed 268 cars and 205 cars, respectively, on the line or in yards along the line, including the yards in Haiphong but not those in the Hanoi area. Four made-up trains were found along the line on 20 June and one on 21 August. Although the full 2,900 tons could have moved out of Haiphong by rail, some of it was probably added to that already carried by inland watercraft and trucks. About 1,000 tons daily could be moved by watercraft between Haiphong and Hanoi utilizing forty 100-ton barges with four days for the round trip. About 700 trucks would be needed to move 1,000 tons per day the full distance between the cities.

2. Highways

Several major and numerous secondary roads serve Haiphong. Route 5, paralleling the railroad line to Hanoi, has a capacity of 5,000 tons each way per day, the highest of any road in North Vietnam. Route 10, with a capacity of 1,000 tons each way per day, provides access to areas both north and south of Haiphong. A number of secondary roads that connect Routes 5 and 10 provide a very flexible and intricate network for the movement of goods out of the port. In addition, the extensive waterway system in the Delta provides an excellent complement to truck traffic, with numerous transshipment facilities available. Vehicle ferries abound on these waterways. Although a number of highway bridges in the Delta area have been attacked, they have been rapidly restored.

3. Water Transport and Transshipment Facilities

Two principal and numerous minor water routes connect Haiphong with Hanoi. The southern route via the Canal des Bambous and the Red River has the largest capacity and is the most heavily utilized. The northern route uses the Song Thai

Binh and Canal des Rapides. Photography of 20 June shows at least 440 barges and sampans on the northern route and 630 on the southern route. On 19 July, 203 were counted on the northern route and 641 on the southern. On both days, many small barges and sampans were noted on the smaller waterways. About 30,000 tons of carrying capacity was represented by the craft sighted on 20 June - 10,000 tons on the northern route and 20,000 on the southern route. The craft sighted on 19 July could carry about 20,000 tons - 6,000 on the northern route and 14,000 on the southern route. All of this capacity was not engaged, however, in handling traffic between Haiphong and Hanoi. Some craft were inactive, some were empty, and some were serving intermediate points. The figures do suggest, however, that watercraft are used in large numbers and that they represent a substantial carrying capacity.

The extent to which the drop in the number of watercraft sighted can be attributed to the air war is not clear. The reduction could be attributed to the demand for watercraft elsewhere in the country. The fear of striking mines cannot be entirely discounted, however, although we have no evidence of watercraft sunk or damaged by these weapons in this area. It is significant that photography reveals no attempts at camouflage of watercraft in the area.

E. LOC's to the South

The capability of the Hanoi to Vinh line to maintain through rail service has been severely restricted by the cumulative effects of the Rolling Thunder program. For the first eight months of 1967, more ordnance was dropped on this line than on the entire railroad system north of the Red River. The line is almost continuously cut at several points, and, because of the interdiction problem, a number of highway bypasses and transloading points have been developed. The substantial repair effort mounted to keep major sections open for shuttle service reflects the

need to maintain overall transport capability and the efficiency of railroads in handling the volume of traffic moving south.

Road and water routes to the south have increasingly served as alternates to the rail line. Route 1A, the major route extending to the DMZ, has a capacity of about 950 tons each way per day during the dry season and 150 tons per day in the wet season in the area south of Vinh and a considerably higher capacity in the area north of Vinh. Route 15, which was extended to the Mu Gia Pass on the Lao border and parallels Route 1A, has a capacity of about 750 tons each way per day during the dry season and 250 tons during the wet season in the area south of Vinh. Canal and inland waterways both north and south of Vinh have been dredged since the bombing began and are being used extensively as are the coastal waterways. In the area south of Vinh, a lightweight meter-gauge rail line over which motor vehicles with flanged wheels operate extends from Tan Ap to the vicinity of Quang Khe. The relative importance of each transport route in the movement of supplies varies according to season and the extent and pattern of interdiction. Although all of these are attacked intensively, their aggregate capacity is much greater than the volume of supplies moved on them. A much larger share of the interdiction effort in the southern route packages is targeted against trucks and watercraft than in the north. As a result the preponderance of destruction to trucks and watercraft in North Vietnam occurs there.

F. Destruction of Transport Equipment

Since January 1965, destruction and damage to transport equipment has included 67 locomotives, 4,792 rail freight cars, 8,371 trucks, and 19,211 watercraft, see Table 1.* The damage and destruction inflicted during June-August 1967 constitutes

* Data on equipment destroyed or damaged are based on pilot reports, which include some duplication.

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a major share of these totals. About one-third of the cumulative damage and destruction of locomotives, rail freight cars, and trucks was reported in these three months. If watercraft are included, the attacks during these three months account for one-fourth of the losses of transport equipment since Rolling Thunder began.

Most of this equipment is destroyed in the southern Route Packages (I-IV). Even during June-August, when LOC targets in Route Packages V and VI were emphasized, 97 percent of trucks, 95 percent of watercraft, and 45 percent of rolling stock reportedly were destroyed in the southern Route Packages.

The effectiveness of attack sorties, in terms of destruction and damage of transport equipment per sortie, has increased throughout the Rolling Thunder program. In 1965, one piece of transport equipment was destroyed or damaged for each nine attack sorties flown. By June-August 1967, one piece was being destroyed for each four attack sorties flown. The effectiveness of air attacks against transport equipment during the first five months of 1967 was about the same as during 1966, but the rate increased markedly in June-August 1967, primarily because of the large increase in the numbers of trucks destroyed and damaged. There was also a large increase in the number of watercraft destroyed and damaged per sortie during June-August 1967 compared with the preceding periods, but it was not as spectacular as the increase noted for trucks. Tables 2 and 3 show data for all transport equipment and trucks separately by time period.

Although the total numbers of transport equipment reported destroyed and damaged during the course of the Rolling Thunder program are impressive, the impact of these losses on North Vietnam's transport capability has not been significant. The railroad rolling stock inventory has remained at the pre-bombing level, and the truck inventory has increased. The watercraft inventory is not known.

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Table 1

North Vietnam: Destruction and Damage of Transport Equipment
 1965 - August 1967

	<u>Loco- motives</u>	<u>Rail Freight Cars</u>	<u>Trucks</u>	<u>Ferries</u>	<u>Barges</u>	<u>Other Water- craft</u>
1965 (10 months)						
Destroyed	6	227	318	53	263	144
Damaged	6	592	487	56	487	210
1966 (11 months)						
Destroyed	10	1,101	1,935	67	2,520	867
Damaged	14	935	1,801	131	4,289	1,372
1967						
Jan-Aug (8 months)						
Destroyed	10	759	2,343	10	2,858	139
Damaged	21	1,178	1,487	10	5,447	288
Jun-Aug (3 months)						
Destroyed	10	614	1,678	10	1,312	29
Damaged	13	839	1,002	5	2,346	23
Total 1965 - August 1967						
Destroyed	26	2,087	4,596	130	5,641	1,150
Damaged	41	2,705	3,775	197	10,223	1,870

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Table 2

Effectiveness of Attack Sorties over North Vietnam
in Destruction and Damage of Transport Equipment a/
1965 - August 1967

Year	Monthly Average of Attack Sorties	Monthly Average of Transport Units		Number of Sorties per Transport Units		
		Destroyed	Damaged	Destroyed	Damaged	Destroyed or Damaged
1965	2,594	101	184	26	14	9
1966	7,470	591	777	13	10	5
1967						
Jan-May	8,168	493	841	17	10	6
Jun-Aug	11,556	1,218	1,409	9	8	4

a. Including locomotives, freight cars, trucks, and all types of watercraft.

Table 3

Effectiveness of Attack Sorties over North Vietnam
in Destruction and Damage of Trucks
1965 - August 1967

Year	Monthly Average of Attack Sorties	Monthly Average of Trucks			Number of Sorties per Truck		
		Destroyed	Damaged	Total	Destroyed	Damaged	Destroyed or Damaged
1965	2,594	32	49	81	81	53	32
1966	7,470	176	164	340	42	46	22
1967							
Jan-May	8,168	133	97	230	61	84	36
Jun-Aug	11,556	559	334	893	21	35	13

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IV. Changes in Transport Requirements and Patterns

A. Changing Requirements

The air campaign over North Vietnam has radically changed the composition and direction of the goods that flow over the North Vietnamese modern transport system. Imports into Haiphong have increased greatly, reaching an average of almost 5,200 tons a day in the second quarter of 1967 and averaging 4,300 tons a day during the first eight months of the year, compared with 2,100 tons per day in the first quarter of 1965.* Ultimately, most of these imports must be distributed by the modern transport system, which is now under intensive attack. At the same time, the bombing has reduced the need for some import traffic. Nearly one-third of the total inbound traffic on the Dong Dang line from China, for example, consisted of coal imports destined for the Thai Nguyen Iron and Steel Complex which has ceased production. (For estimated international traffic moving on rail lines in 1964 and August 1967, see Figure 6.) The bombing has also greatly reduced North Vietnamese exports. Exports of apatite virtually ceased in August 1965, and exports of cement and pig iron ceased this year. This reduction of export traffic, particularly apatite and pig iron, has provided further relief to the transport system, especially the railroads. The general disruption of industry resulting from bomb damage and shortages of electric power have reduced further the traffic that must move over the transport system. Even the large-scale evacuation of the population from urban areas to rice-growing rural areas, while creating many serious problems for Hanoi, has reduced North Vietnam's modern transport problem. Finally, Chinese transit traffic, amounting to 1,300 tons per day, no longer crossed North Vietnam between Nanning and K'un-ming after the attacks on the Lao Cai line began in 1965. A new rail line in China for this traffic was completed in early 1966.

* These figures include an estimated annual 150,000 tons - 400 tons per day - of unidentified cargoes, primarily from China.

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The net effect of the removal of Chinese transit traffic and changes in traffic requirements and patterns induced by the bombings is that the North Vietnamese modern transport system is presently carrying only about 90 percent of the volume of traffic it carried during 1966. This explains, in part, why the North Vietnamese have been able to distribute the large volumes of economic and military aid coming into the country. Furthermore, at the same time that the volume of traffic has lessened, the capacity of the transport system has increased so that essential traffic can move at night or when bad weather limits the effectiveness of airstrikes. In 1964, for example, the Hanoi-Haiphong line transported an estimated 3,750 tons of international traffic in both directions (2,350 tons westbound and 1,400 tons eastbound). Presently, despite the large imports into Haiphong, the line is estimated to be handling only 3,150 tons daily both ways (2,900 tons westbound and 250 tons eastbound). The capacity of the Hanoi-Haiphong line is presently estimated at 4,000 to 5,000 tons each way per day. The Hanoi - Dong Dang line, which was being used at about one-third of its pre-bombing capacity, is now being used at about one-fourth of that capacity and an even smaller share of its dual-gauge capacity.

B. Changes in Imports and Exports

The war has induced a drastic increase in North Vietnamese imports, particularly of economic and military aid from the USSR and Communist China. Seaborne imports, for example, increased from an average of nearly 3,000 tons a day in 1966 to 4,300 tons a day during the first eight months of 1967. Almost all of this import traffic must be distributed over the main domestic transport network. Excluding exports of coal and cement, which do not move over the main transport network, there has been a drastic decrease in export traffic that offsets the increase in imports. The movement of international traffic has shifted from a "two-way" to a "one-way" flow as shown in the following tabulation:

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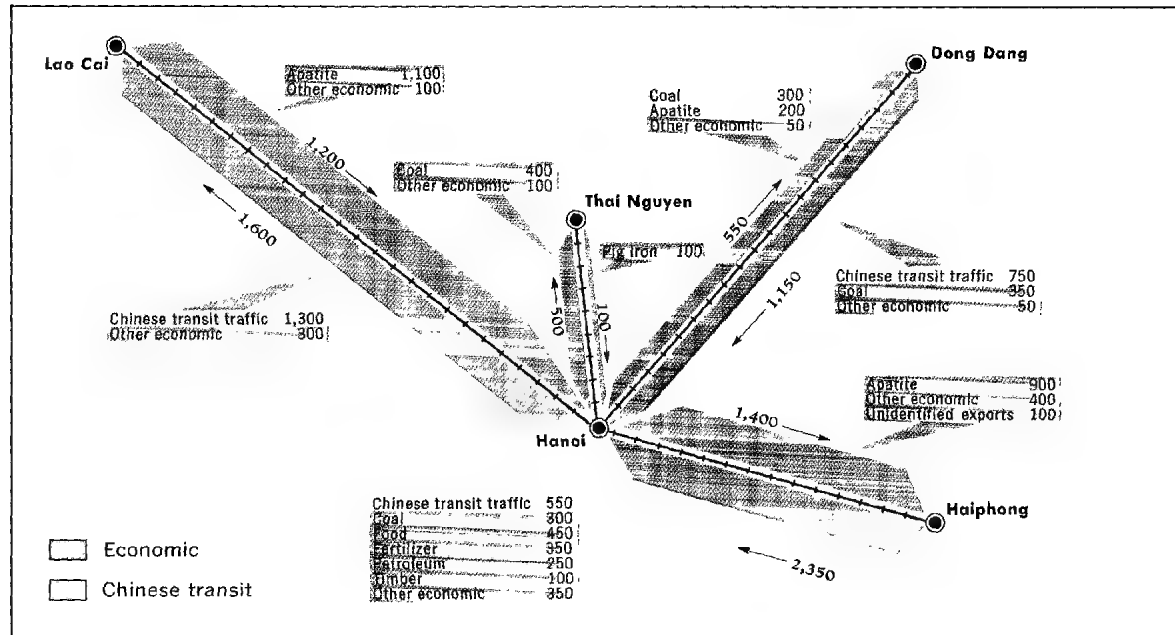
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Figure 6

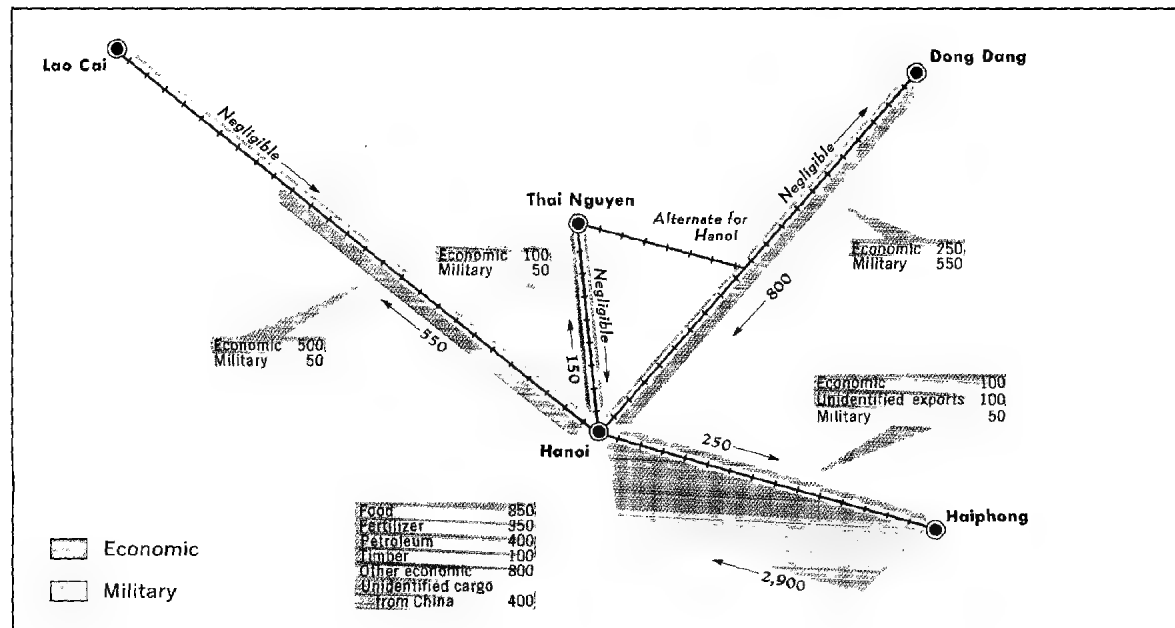
Estimated International Traffic Carried on North Vietnamese Railroads

Volume in Metric Tons per Day (to nearest 50)

1964



AUGUST 1967



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	<u>Metric Tons per Day</u>		
	<u>1964</u>	<u>August 1967</u>	<u>Change</u>
Imports	3,300 <u>a/</u>	5,100 <u>b/</u>	+ 1,800
Exports <u>c/</u>	2,000	200	- 1,800
Total	<u>5,300</u>	<u>5,300</u>	<u>0</u>

- a. Including Chinese transit traffic.
- b. Average during January-August 1967 for sea-borne imports and current rail imports.
- c. Excluding coal and cement which does not move on the main transport network.

C. Changes in Domestic Requirements

The reduction in industrial production because of bomb damage to modern industry and, to a lesser extent, the urban evacuation carried out during 1966 and 1967 have brought about a net decrease in domestic traffic requirements. The decreases in traffic are estimated as follows:

	<u>Metric Tons per Day</u>
Coal for electric powerplants	1,700
Coal for cement production	570
Coal for other industry	1,000
Cement	650
Apatite	550
Pig iron	270
Textiles	60
Foodstuffs	400
Total	<u>5,200</u>

Thus about 5,200 tons of the estimated 55,300 tons of traffic carried per day on the modern transport system in 1966 did not need to be moved by the end of August 1967 -- a reduction of nearly 10 percent. A large portion of the lost traffic had been moved on the railroads, which probably originated about 9,000 tons of freight per day in 1966. These reductions in traffic that moved principally by

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rail have provided slack for the movement of those imports needed to continue the war effort and maintain a minimum standard of living.

D. Haiphong Port

1. Increase in Imports

Haiphong normally receives more than 95 percent of North Vietnam's seaborne imports and about three-fourths of total imports. Imports have increased from an average daily volume of 2,100 tons in the first quarter of 1965 to a peak of almost 5,200 tons in the second quarter of 1967. This tonnage has been verified from intelligence sources except for an estimated 400 tons a day. Haiphong's volume of identified imports and exports since 1964 are given in Tables 4 and 5. Although much of the increase in imports this year has been foodstuffs, very significant and consistent increases also have occurred in imports of miscellaneous and general cargoes and petroleum products. Imports of miscellaneous and general cargo have consisted largely of Soviet and Eastern European rolled steel products (especially rails and structural steel), trucks, construction equipment, machinery and spare parts, barges, cable and wire, chemicals, and textiles. General cargo shipments from Communist China have been of smaller volume than those from either the USSR or Eastern Europe but have included many of the items listed above, as well as coking coal and gypsum. Most of the growing volume of petroleum product imports has been provided by the USSR, but China has supplied about 23 percent of the petroleum delivered by sea in the first eight months of 1967. There is still no evidence that military hardware is entering North Vietnam via Haiphong, although war-supporting equipment, such as trucks, does arrive by sea.

2. Port Congestion

Despite the destruction of much of North Vietnam's fixed petroleum storage capacity and tanker discharge facilities at Haiphong in June and July 1966, seaborne deliveries of petroleum were back to pre-strike levels by December 1966, and in the first quarter of 1967 deliveries averaged 26,500 tons -- a somewhat larger quantity than in any quarter since

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31 December 1964. Haiphong port authorities have also had to cope with sharply increased quantities of dry cargo imports.

Although sharply increased levels of imports were cleared through the port of Haiphong, difficulties were encountered in doing so, as seen in the growing layover times for both dry cargo ships and tankers. Layover times of freighters at Haiphong averaged ten days in the first six months of 1966, but increased to nearly 17 days in the third quarter of 1966 following a sharp increase in deliveries of miscellaneous and general cargoes. Similarly, the large increase in imports in the second quarter of 1967 was followed by increased layover times that reached a peak average of 33 days for freighters clearing the port in August. The extended delays are attributable primarily to poor port management and a possible shortage of lighter capacity.

Over the past 18 months, there has been a notable spillover of cargoes into areas adjacent to the port area at Haiphong. Vacant lots, parks, and even streets and sidewalks have been utilized for storage of cargoes. Comparison of photography of April and August 1967 shows further extensions of areas used for open storage. The photography also reveals an active turnover of goods in these storage areas, indicating that storage is largely temporary. The pileup of supplies in the port area apparently developed because of failure to adjust and speed up cargo-handling and distributing procedures sufficiently to keep pace with the increased quantities of imports. Attacks on transport routes around Haiphong almost certainly have not contributed significantly to the accumulation of goods in the port area.

Haiphong's potential for handling even larger volumes of imports is excellent. In view of the port's ideal access to the country's road, rail, and waterway networks, the principal limiting factor is the capability for transferring cargoes from ships to these distribution lines. Apparently recognizing this, Haiphong port authorities have undertaken construction of a new wharf that will

add at least one berth to the seven existing berths for oceangoing ships. Additionally, North Vietnam appears to have stepped up imports of barges in 1967. Delivery has begun from Communist countries of at least 200 barges with an aggregate capacity of at least 15,000 deadweight tons. The additional barge capacity will significantly increase the capability for lightering cargoes from ships and moving shipments over inland waterways.

Table 4

North Vietnam: Average Monthly Volume of Seaborne Imports Identified on Foreign Ships
by Quarter, January 1965 - August 1967

(Thousand Metric Tons)

	1965				1966				1967		
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Aug ^{a/}
Total	50.4	55.8	48.5	77.7	80.1	81.4	71.5	75.7	113.2	143.1	90.0
Bulk foodstuffs	5.3	7.2	9.0	18.1	3.5	6.2	3.4	12.8	23.8	55.5	26.1
Fertilizer	13.2	15.7	10.8	14.4	28.5	15.0	14.4	17.5	25.3	11.9	10.0
Petroleum, oil, and lubricants	11.4	18.4	4.7	22.2	18.0	26.1	9.1	13.8	26.5	20.9	18.7
Timber	2.3	1.4	0.6	0.6	2.2	1.1	0.9	0.3	2.4	0.3	2.4
Miscellaneous and general cargoes	18.2	13.1	23.4	22.4	27.8	33.0	43.6	31.3	35.2	54.5	32.9

a. A two-month period.

Table 5

North Vietnam: Average Monthly Volume of Seaborne Exports Identified on Foreign Ships
by Quarter, January 1965 - August 1967

	1965				1966				(Thousand Metric Tons)		
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Aug a/
Total	168.0	142.6	127.4	133.0	146.5	82.7	61.6	98.2	94.1	43.9	27.3
Apatite	55.6	31.8	18.3				3.5				
Cement	11.6	7.3	4.4	2.8	7.0	13.3	6.2	6.5	10.0	1.3	
Coal	80.3	92.8	93.5	116.7	136.6	62.0	43.6	70.6	69.6	32.1	24.8
Pig iron	9.2	1.7	3.2	1.7		0.5	2.8	10.0	6.1	1.1	
Miscellaneous and general cargoes	11.2	8.9	8.0	11.8	2.9	6.9	5.5	11.2	8.4	9.4	2.5

a. A two-month period.

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V. The Logistics Burden of the Transport System

A fuller appreciation of North Vietnam's ability to withstand the impact of a sustained and intensive air interdiction campaign can be gained by examining those war-supporting transport functions which are essential to the conduct of the war in the South. North Vietnam provides little direct input into the war other than its manpower. The basic sustenance that enables the war to continue is the material input provided by the USSR and Communist China. Among the most important elements of this external assistance are the supplies needed to meet essential military and civilian requirements in the logistic funnel which runs south of Hanoi through the panhandle of North Vietnam, to the Communist forces in Laos, in the DMZ area, and in South Vietnam. Although the flow of external assistance to North Vietnam is increasing continuously, only a small share of this aid must be transported south from Hanoi to South Vietnam.

A. Area South of the Red River

The area south of the Red River includes 55 percent of North Vietnam's civilian population and 63 percent of its armed forces. Two-thirds of this North Vietnamese civilian population is concentrated in the Delta between the Red River and the 20th Parallel. About 57 percent of the armed forces in the area south of the Red River are located in Route Package VI south of the Red River and in Route Package IV.

We estimate, in very general terms, that the civil and military requirements in the area south of the Red River approximate 2,000 tons a day (see Table 6). The movement of this small tonnage is then the key logistics problem of the North Vietnamese transport system. As these supplies move south, they are drained off by consumers along the route so that only extremely small tonnages emerge at the end of the logistics system. These small flows require the utilization

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of only a small part of the diverse transport connections running through Laos or to the DMZ area.

The military supply requirement of the Communist forces in North Vietnam deployed south of the Red River plus supplies provided by North Vietnam to forces in Laos and South Vietnam is estimated to be about 740 tons* per day, including about 200 tons of ammunition, engineering supplies, and equipment; 275 tons of food, most of which is supplied from domestic resources; and about 265 tons of POL products. The civilian population located in the same areas is estimated to consume roughly 1,200 to 1,300 tons per day of imported supplies, such as POL, fertilizer, tools and equipment, and clothing and medicine - goods which are mainly imported via Haiphong. In addition to these shipments, which must be imported from outside the area, there is a small flow of domestically generated civilian traffic, most of which moves only short distances.

These estimates do not include an allowance for the quantities of supplies and transport equipment destroyed by air attacks. Even if this rate of loss were as high as 30 percent, it would not represent a large absolute increase in the tonnage to be transported. Given the pattern of attacks against LOC's and storage sites and the pattern of reported destruction, it is evident that the rate of loss increases as supplies move south. Figure 7 shows the movement of supplies to the several end-use areas.

Because the civilian population and the military forces are heavily concentrated in the Delta area, their essential requirements constitute about three-fourths of the supplies - 1,500 tons - that must move south of Hanoi. This

* In this memorandum, military requirements are expressed in metric rather than short tons to make them consistent with transportation estimates. Thus, the military requirements figures will differ from those usually used in our estimates of Communist logistics requirements.

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Table 6

Estimated Civilian and Military Supply Requirements
Provided by North Vietnam, by Area

Metric Tons per Day			
Area	Civilian Requirement	Military Requirement	Total
Hanoi area of Route Package VI south of Red River and Route Package IV	1,080	420	1,500
Route Packages I, II, and III	165	235	400
DMZ	0	40	40
Laos	0	35	35
South Vietnam	0	10	10
Total	<u>1,245</u>	<u>740</u>	<u>1,985</u>

movement is easily handled by a diversified transport system extending through the Delta to Haiphong and up to the Chinese border, and distances are not great. Ninh Dinh, a junction point in the southern Delta, is 110 kilometers from Haiphong by road and 293 kilometers from P'ing-hsiang, China, by rail.

The remaining 500 tons per day that must move into the Panhandle (Route Packages I, II, and III) are predominantly military supplies - 320 tons - and are moved over relatively longer distances. These requirements are not large, however, and although the air campaign has been largely concentrated against the LOC's in the South, the supply system has been improved and the requirements delivered.

Food rations, POL supplies, and air defense ammunition expenditures account for most of the military requirement. The military POL requirement includes an allowance for aircraft, naval vessels, military wheeled vehicles, armored vehicles, and generators. In addition, a substantial share of civil transport activity is devoted to the movement of military equipment and material. Table 7

Table 7

Military Supply Requirements Provided by North Vietnam for Communist Forces
in the Southern Regions of North Vietnam, Laos, and South Vietnam

						Tons per Day
Class of Supply	Hanoi Area of Route Package VI South of Red River and Route Package IV	Panhandle (Route Packages I and III)	DMZ	Laos ^{a/}	South Vietnam Other than DMZ	Total
Class I (food)	127	100	27	20	Negl.	274
Class II and IV (clothing and equipment)	22	18	5	5	3	53
Class III (POL)	181	72	5	9	Negl.	267
Class V (ammunition)	90	45	3	1	25 ⁷ X 1	146
Total	<u>420</u>	<u>235</u>	<u>40</u>	<u>35</u>	<u>10</u>	<u>740</u>

a. Requirements in the dry season; monsoon requirements are about 75 percent of dry season requirements.

shows estimated military requirements by class for selected areas of North Vietnam, the DMZ area, Laos, and South Vietnam.

Air defense ammunition and SAM expenditures amount to about 258 tons per day for all of North Vietnam, with about 35 percent of the total concentrated in the Hanoi area south of the Red River and in Route Package IV. Roughly 20 percent of air defense ammunition is expended in Route Packages I, II, and III. Only about one ton of ammunition per day is expended for training purposes.

The remaining supply items required by military forces in North Vietnam are made up of Class II and IV technical supplies: primarily engineering, transportation, quartermaster, and medical supplies.* It is estimated that on the order of 40 tons per day of these are required by forces in North Vietnam south of the Red River in Route Packages I through IV and VI. Engineer-supplies used on the construction and repair of lines of communication make up most of the technical supply requirement.

Despite the heavy bombing of rail lines from China and the port of Haiphong and disruption of LOC's in the South, it appears that food and building materials for workcamps repairing bomb damage in Route Packages I, II, and III south of Hanoi continue to move. A workcamp in Quang Binh Province, probably operating on Route 1A, 101, or 137, was to receive two bulldozers and 30 tons of steel on 20 June from Hanoi. A logging camp in Nghe An Province which provides, among other things, timber for bridge repair was to receive an additional 25 tons of rice on 15 June. Although some intercepted messages

**. Weapons and signal and chemical equipment are also included in the Class II and IV category. Estimates for Class II and IV supplies include a replacement factor for wear and tear but no allowance for destruction by opposing forces.*

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reflected "bad traffic conditions" south of Hanoi, there were other reports of small shipments of asphalt, cement, and gas generators to workcamps in the southern part of the country in June and July.

B. The DMZ Area

Currently, Communist forces in the DMZ area require about 40 tons of supplies per day, practically all of which are provided by North Vietnam. Requirements in this region are higher per soldier than elsewhere in South Vietnam because the rate of combat has been high, and the troops are predominantly well equipped North Vietnamese regulars. Food supplies represent about two-thirds of the daily resupply requirement for these forces.

The ammunition requirement, although low in comparison with the requirement for food, is beginning to rise. Estimated ammunition expenditures of three tons per day include an allowance for artillery fired into South Vietnam from positions within or north of the DMZ as well as mortar and rocket firing in the northern part of Quang Tri Province. The use of these weapons has increased dramatically in recent weeks.

C. Laos and South Vietnam

The average daily volume of truck traffic observed moving into Laos from North Vietnam during the past dry season along with supplies procured locally and from Cambodia was more than adequate to meet external requirements of Communist forces in Laos and in South Vietnam. The volume of truck traffic suggests that Communist forces were able not only to satisfy dry season requirements, but also to build up stockpile levels in anticipation of the current rainy season and increased levels of consumption or loss. There is also some evidence that the level of truck traffic has remained fairly high during the current rainy season.

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1. Laos Panhandle (see Figure 8)

Communist forces in the Laos Panhandle currently require about 20 tons of supplies per day from North Vietnam in the dry season and about 15 tons of supplies per day in the rainy season. Nearly half of these are food. Only about one-fourth (5 tons) of Class II and IV requirements need to be brought in from North Vietnam. Ammunition expended in ground combat and antiaircraft reactions amounts to less than a ton per day.

2. Northern Laos

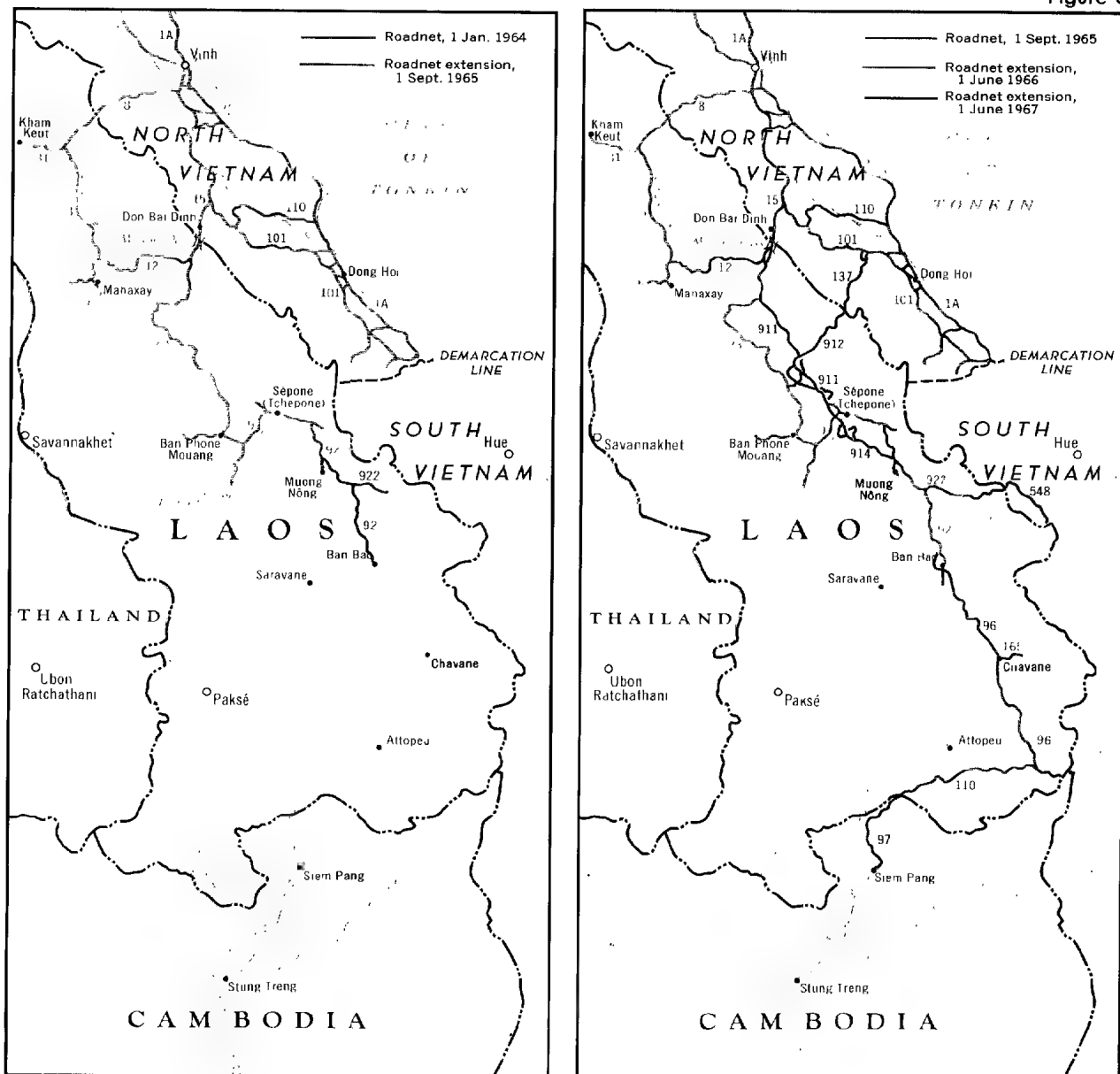
Communist forces in the northern part of Laos require about 15 tons of supplies per day from North Vietnam in the dry season and about 12 tons in the rainy season. Most of these supplies consist of food and POL, as combat is light and construction activity minor. Ammunition expenditures in northern Laos are negligible.

3. South Vietnam

Communist forces currently deployed in South Vietnam require between 45 and 55 tons of supplies per day from external sources to sustain their present level of combat operations. Only about 10 tons of these supplies, principally weapons, equipment, and ammunition, are supplied from North Vietnam through the Laos Panhandle. The remaining tonnages are moved directly across the DMZ, supplied from Cambodia either directly across the border or through the Laos Panhandle (a minimum of 10 tons of food per day from Cambodia for Communist forces in South Vietnam transits the Laos Panhandle), or are infiltrated by sea.

Road Network - Laos Panhandle

Figure 8



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0 25 50 75 100 Miles
0 25 50 75 100 Kilometers

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VI. Countermeasures to Attacks on LOC's

The ability of the North Vietnamese to offset the effects of bombing is explained, in part, by the primitive target system that US air power is trying to neutralize. Much of the success of the North Vietnamese, however, is explained by the numerous countermeasures they have developed or borrowed. The resourcefulness and determination of the North Vietnamese to counter the effectiveness of the US bombing is more evident in the transport sector than anywhere else.

Contingency planning by the North Vietnamese, with Chinese Communist aid, has diminished the full effect of the increased bombing of the northern LOC's. Using a large labor force and local building materials, the North Vietnamese have built bypass railroad bridges and have improved fords, pontoon bridges, and ferries to insure the movement of supplies from Haiphong port and China via the major road and rail arteries. The North Vietnamese anticipated the recent escalation of bombing by at least one year. Since July 1966 there has been photographic evidence of bypass bridges being constructed and the reinforcing of existing bridges in the Hanoi and Haiphong areas. Stockpiles of repair materials along major LOC's have long been in evidence. Thus the effect of long-range planning and contingency construction by the North Vietnamese has been to disperse the pre-strike chokepoints on LOC's, thereby greatly complicating the task of interdicting supplies.

A. Bypasses

1. Type and Number

A wide variety of bypasses have been built by the North Vietnamese to counter the effectiveness of US air attacks against LOC's. The type of bypass constructed is generally determined by the terrain. The number of bypasses at a particular crossing depends on the strategic importance of the route and its traffic volumes. The North Vietnamese have employed a variety of

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bridging techniques, many of which were borrowed from Chinese experience during the Korean War. At river crossings along critical routes, there are usually one or sometimes two alternate railroad bridges and a rail ferry for backup. At combination bridges, one or more pontoon bridges and vehicle ferries are located to handle highway traffic.

The success of the North Vietnamese and Chinese Communist construction effort in the Delta and north of Hanoi and the significance attached to the various transport routes can be seen by the average number of bypasses built for damaged railroad and combination railroad/highway bridges on each line. The figures include all types of bypasses at damaged or destroyed bridges - alternate railroad bridges, rail ferries, pontoon bridges, and highway fords and ferries. Rail-to-water transshipment points are not included in the table. As shown in Table 8, the important Hanoi-Dong Dang line and Route 1A have the largest average number of bypasses.

Table 8

Average Number of Bypasses per Damaged Bridge on Selected Rail Lines

<u>Rail Line/Route</u>	<u>Bridges Damaged/Destroyed</u>	<u>Number of Bypasses</u>	<u>Average Number of Bypasses per Bridge</u>
Hanoi - Dong Dang line and Route 1A	7	25	3.57
Hanoi-Haiphong line and Route 5	3	5	1.67
Hanoi - Thai Nguyen - Kep line	4	5	1.25
Hanoi - Lao Cai line	25	15	0.60

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Many of the alternate bridges are used together with the original bridges in a "tandem service" arrangement. Aerial photography usually shows only one bridge serviceable because many alternate bridges are constructed with removable decking or sliding spans to give the impression that the alternate is still under construction and not serviceable to traffic. The decking is put in place at night when the bombing diminishes (see Table 9).

In addition to the bypasses built on major rail lines, concealed rail sidings, rail-to-water transshipment points, and new railroad yards have been built to protect rolling stock caught unexpectedly at newly destroyed bridges and to permit more options in dispatching traffic on the bombed rail lines. Camouflaged sidings have been noted on the Lao Cai line where the terrain affords excellent cover for temporarily stranded rolling stock (see Figure 9). Rail-to-water transshipment points have been constructed at Bac Giang and Dap Cau on the heavily used Dong Dang line, at Hai Duong and Ngoc Kuyet on the Haiphong line, and at Ha Gia on the Thai Nguyen line - all on navigable waterways that interconnect to provide bypass or alternate LOC's. At least seven new railyards plus numerous sidings have been built since early 1966 on the two rail lines connecting Hanoi with China. Many of them are located near heavily bombed bridges and serve to make rail traffic more flexible and to allow repair workers greater option in choosing which yards to keep serviceable at any time.

2. Rate of Repair

Many of the damaged bridges and bypasses have been repaired or completely rebuilt with phenomenal speed. Engineering troops and conscripted local workers are responsible for preassigned targets and arrive at the bombed areas frequently within one to three hours after a strike. In addition, stockpiles of construction materials such as crushed stone and lumber are pre-positioned at strategic points and trained demolition units are organized to remove or detonate delayed action bombs. Cratered

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Table 9

Maximum Repair Times at Selected Bridges on Rail Lines
in North Vietnam

<u>Rail Line and Bridge Name</u>	<u>Dates of Photography</u>	<u>Days</u>	<u>Type of Repair</u>
Dong Dang line			
Hanoi Railroad/Highway Bridge over Red River	11, 30 Aug 1967	19	Two piers, 250 feet of deck for vehicles
Hanoi Railroad/Highway Bridge over Canal des Rapides	30 Apr, 10 Jun 1967	41	Two piers, 214 feet of deck on original bridge plus 670 feet of deck on bypass bridge
Cap Cau Railroad/Highway Bridge	10, 17 Jun 1967	7	200 feet on bypass bridge
Bac Giang Railroad/Highway Bridge	30 Apr, 1 May 1967	1	106 feet (two new spans)
Lao Cai line			
Lang Bun Railroad Bridge	19 Sep, 9 Oct 1965	20	New 160-foot bridge with three cribbed piers
	29 Oct, 9 Nov 1965	11	80 feet repaired
	28 Sep, 8 Oct 1966	10	Replaced deck
Lang Quach Ngoai (BE 616-01095)	28 Aug, 8 Sep 1965	11	New 80-foot bridge on old abutments
Lang Quach Ngoai (BE 616-01094)	7, 12 Oct 1965	5	New 80-foot bridge
Lang Khay (BE 616-1133)	25, 31 Jul 1965	6	New 30-foot span
	7, 8 Oct 1966	1	Replace and realign track on bridge
	21 Nov, 3 Dec 1965	12	New abutment, and 80-foot span

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Table 9

Maximum Repair Times at Selected Bridges on Rail Lines
 in North Vietnam
 (Continued)

Rail Line and Bridge Name	Dates of Photography	Days	Type of Repair
Lao Cai line (continued)			
Lang Khay (BE 616-1132)	21 Nov, 3 Dec 1965	12	New 60-foot bridge
Pho Hop Railroad Bridge	8, 12 Oct 1966	4	Heavy superstructure damage
Dai Loi Railroad Bridge	1, 3 Aug 1967	2	Placed track to serviceable bypass bridge
Tho Khoi	7, 12 Aug 1966	5	Realigned 75-foot through truss and connected track
Lang Khay (BE 616-1131)	12, 18 Jul 1966	6	New 75-foot bridge on old abutments
	23, 31 Jul 1966	8	Repaired two twenty-foot spans and one pier
	23 Jul, 7 Aug 1966	15	New 90-foot bridge
Haiphong line			
Hai Duong Railroad/Highway Bridge West	12 Aug, 12 Sep 1966	31	Repaired 255 feet (three spans)
Hai Duong Railroad/Highway Bridge East	21 Jun, 1 Jul 1967	10	Realign and raise 145-foot dropped through truss span

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sections of roads and railbeds are repaired within five to ten hours, and bridges or bridge sections under 100 feet have been built within two to four days after a successful strike (see Table 10 and Figure 10).

B. "Hardening" of LOC's

1. Dong Dang Rail Line

Constructing multiple bypasses has enabled the North Vietnamese to harden their LOC's to such a degree that the capacity of most important highways and rail lines at present is considerably higher than during the early days of the bombing when natural fords and ferries were the primary means to bypass destroyed bridges. The increased bombing along the Dong Dang line since June 1967, for example, has included successful strikes against three key bridges in addition to those previously hit, but there is a serviceable bypass now in operation at each of these three bridges. The recent airstrikes also included initial strikes against railyard targets previously not authorized for attack. All of these yards have been bypassed or were quickly restored to full service. Strikes against railyards seem, therefore, to offer little promise of interrupting through rail service for extended periods.

The most important bridge interdiction on the Dong Dang line was the result of the 11 August strike against the Hanoi Railroad/Highway Bridge over the Red River in which about 250 feet of this mile-long bridge was destroyed. Cutting rail service on this bridge, the only connection to Hanoi over the Red River, has affected the flow of traffic, but there are four highway ferries, one vehicle pontoon bridge, and a rail ferry with slips for use during periods of low, medium, and high water in operation along a ten-mile section of the Red River south of the bridge. Repair work on the bridge was seen on 30 August and 17 September, and it is now serviceable for vehicular traffic. Five miles northeast of Hanoi, the railroad/highway bridge over the Canal des Rapides and its bypass

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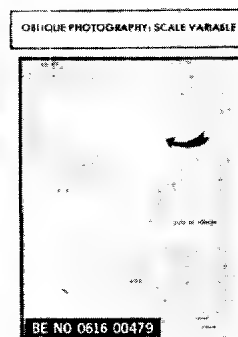
Figure 9. Concealment Sidings, Hanoi-Lao Cai Railroad, North Vietnam NPIC

These photos show construction of three new sidings on the Lao Cai rail line to provide concealment for rolling stock whenever the rail line has been cut by airstrikes.

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Figure 10. The Bac Giang Combination Railroad/Highway Bridge on the Hanoi/Dong Dang Line and Route 18 (21-16-30N, 106-11-18E), April 1967



An example of rapid repair of bomb damage is illustrated in this sequence of photographs.

Strike photography of 30 April 1967 indicated that a direct hit dropped two spans of the Bac Giang Bridge.



One day later the bridge had been temporarily repaired and was serviceable to rail traffic. Photography on 13 May indicated that the bridge had been completely repaired and serviceable to both rail and highway traffic.

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Table 10

Bypasses and Other Countermeasures on Rail Lines in the Northern Part of North Vietnam

Rail Line and Bridge Name	Length of Original Bridge (in feet)	Type and Number of Bypasses	Other Countermeasures
Dong Dang line			
Hanoi Railroad/Highway Bridge over Red River	5,532	3 rail ferries 4 vehicle ferries 1 pontoon bridge	29 support piers were built to minimize the effects of bombing
Hanoi Railroad/Highway Bridge over Canal des Rapides	738	1 rail bridge 2 rail ferries 1 highway ferry 1 pontoon bridge	25X1
Dap Cau Railroad/Highway Bridge	530	1 rail bridge 2 vehicle ferries 2 pontoon bridges	A rail-to-water trans-shipment point
Bac Giang Railroad/Highway Bridge	460	1 rail bridge 2 ferry crossings 1 pontoon bridge	A rail-to-water trans-shipment point
Vu Chua Railroad Bridge	100		Repaired original bridge
Cao Nung Railroad Bridge	175	1 rail bridge	

Table 10

Bypasses and Other Countermeasures on Rail Lines in the Northern Part of North Vietnam
(Continued)

<u>Rail Line and Bridge Name</u>	<u>Length of Original Bridge (in feet)</u>	<u>Type and Number of Bypasses</u>	<u>Other Countermeasures</u>
Dong Dang line (continued)			
Lang Son Railroad/Highway Bridge	350	2 rail bridges	
Total bypasses (25)			
Total bridges (7)			
Haiphong line			
Ngoc Kuyet Railroad/Highway Bridge	155	1 rail bridge	25X1
Hai Duong Railroad/Highway Bridge West	1,290	1 rail bridge	A rail-to-water trans-shipment point
Hai Duong Railroad/Highway Bridge East	440	2 rail bridges 1 pontoon bridge	
Haiphong Railroad/Highway Bridge	300	1 rail bridge	Reinforcing piers on main bridge
Total bypasses (6)			
Total bridges (4)			
Kep - Thai Nguyen - Hanoi Line			
Ha Gia Highway Bridge	320	2 constructed fords 1 natural ford	

Table 10

Bypasses and Other Countermeasures on Rail Lines in the Northern Part of North Vietnam
(Continued)

Rail Line and Bridge Name	Length of Original Bridge (in feet)	Type and Number of Bypasses	Other Countermeasures
Kep - Thai Nguyen - Hanoi Line (continued)			
Hai Gia Railroad Bridge	320		Repaired original A rail-to-water trans-shipment point
Dong Muc	370	1 rail bridge	
Lang Lau	240	1 rail bridge	
Total bypasses (5)			25X1
Total bridges (4)			
Lao Cai line			
Lang Bun Railroad Bridge	125	2 rail bridges	
Lang Khay Railroad Bridge No. 2	45	N.A.	N.A.
Som Dong Dep Railroad Bridge	60		Repaired original bridge
Trai Hut Railroad Bridge Northwest	75		Repaired original bridge
Lang Quach Ngoai Railroad Bridge	80		Repaired original bridge
Lang Quach Ngoai Railroad Bridge No. 2	89	1 rail bridge	
Som Hang Railroad Bridge	95	1 rail bridge 1 highway bridge	

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Table 10

Bypasses and Other Countermeasures on Rail Lines in the Northern Part of North Vietnam
(Continued)

<u>Rail Line and Bridge Name</u>	<u>Length of Original Bridge (in feet)</u>	<u>Type and Number of Bypasses</u>	<u>Other Countermeasures</u>
Lao Cai line (continued)			
Lang Bo Railroad Bridge	60		Repaired original bridge
Lang Khay Railroad Bridge Northwest	70	1 rail bridge	
Lang Khay Railroad Bridge South	60		Repaired original bridge
Lang Khay Railroad Bridge	135		Repaired original bridge
Trai Hut Railroad Bridge	65	1 rail bridge	Repaired original bridge
Pho Chang Railroad Bridge South	53		Repaired original bridge
Lang Thip Railroad Bridge	80		Repaired original bridge
Pho Hop Railroad Bridge	90	1 rail bridge	
Dai Loi Railroad Bridge	310	2 rail bridges	
Tho Khoi Railroad Bridge	75		Repaired original bridge
Phu Tho Railroad Bridge	80		Repaired original bridge
Lang Khay Railroad Bridge	76		Repaired original bridge
Chieu Ung Railroad Bridge	90		Repaired original bridge
Tuan Quan Railroad Bridge	65		Repaired original bridge
Khe Se Railroad Bridge	75		Repaired original bridge

Table 10

Bypasses and Other Countermeasures on Rail Lines in the Northern Part of North Vietnam
(Continued)

<u>Rail Line and Bridge Name</u>	<u>Length of Original Bridge (in feet)</u>	<u>Type and Number of Bypasses</u>	<u>Other Countermeasures</u>
Lao Cai line (continued)			
Pho Chang Railroad Bridge	75		Repaired original bridge
Lenh Khanh Railroad Bridge Southeast	45		Repaired original bridge
Viet Tri Railroad/Highway Bridge	1,000	2 rail ferries 2 vehicle ferries 1 pontoon bridge	Original bridge under repair using cable anchorages
Total bypasses (15)			25X1
Total bridges (25)			

rail bridge also were successfully interdicted on 11 and 22 August (see Figure 11). Rail and highway ferries have been in operation at this crossing, and the original bridge was serviceable to rail and highway traffic by at least 17 September. The destruction of the Lang Son railroad bridge on this line in the buffer zone on 13 August has not stopped rail traffic because a completed bypass rail bridge exists nearby (see Figure 12). The remainder of the previously struck railroad bridges or their bypass rail bridges have been kept in "tandem service" during this period.

Contingency planning has been particularly obvious on the Dong Dang line. Between May and November 1966, there were up to 29 reinforcing piers installed under the Hanoi Railroad/Highway Bridge to prevent complete collapse of long bridge sections from direct hits. During the spring of 1967 a rail bypass around Hanoi was constructed from the Haiphong to the Vinh line incorporating an elaborate rail ferry which has three slips on each river bank for use during low, medium, and high water levels. Photography of 31 August showed this ferry in operation and rolling stock on each bank of the Red River. At the Canal des Rapides crossing located five miles northeast of Hanoi, the rail bypass bridge was under construction nine months before the first strike on the original bridge. Twenty days after the initial strike, this bypass bridge was in operation for through rail traffic. At Lang Son a rail line bypassing the town, which included a railroad bridge, was under construction in July 1966, 13 months before the initial strike.

The Dong Dang line is kept serviceable by elements of the Chinese 2nd Railway Engineering Division with an estimated 6,000 to 10,000 troops. There have been no indications of an increase in Chinese troop strength to cope with the additional damage on this line. The existing force apparently is still able to provide rapid repair of bomb damage. When two 53-foot spans were dropped at the Bac Giang Railroad/Highway Bridge on 30 April, the Chinese had it repaired and serviceable one day later. During their tenure on this line

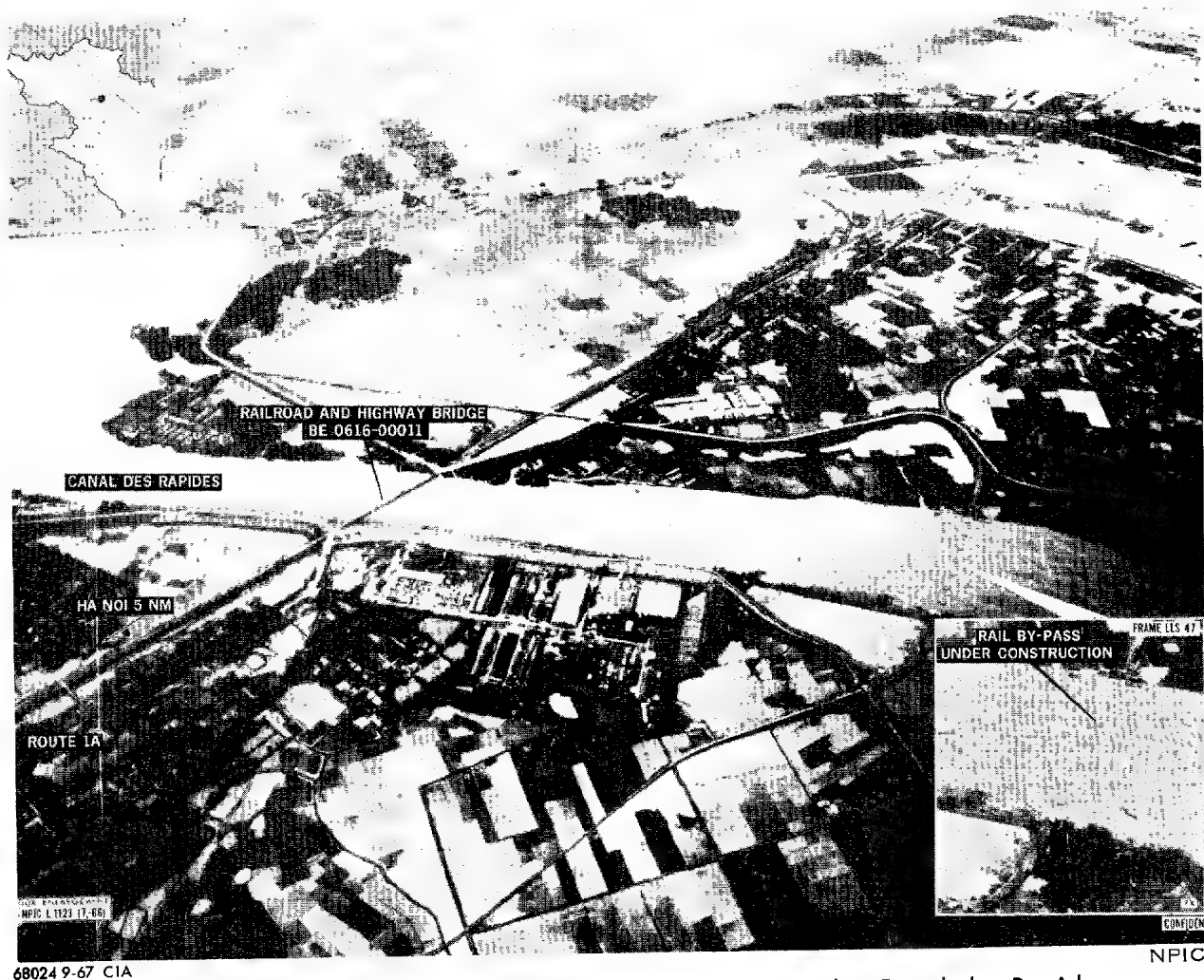


Figure 11. The Hanoi Railroad/Highway Bridge over the Canal des Rapides (21-04N 105-55E), 29 June 1966

The North Vietnamese started construction of a bypass bridge just northeast of Hanoi on the rail line from China almost one year prior to an attack on the existing bridge. The main bridge was first damaged in late April 1967. Photography in mid-May 1967 indicated that the bypass bridge was serviceable and that a second bypass bridge was under construction (not shown in the photo).

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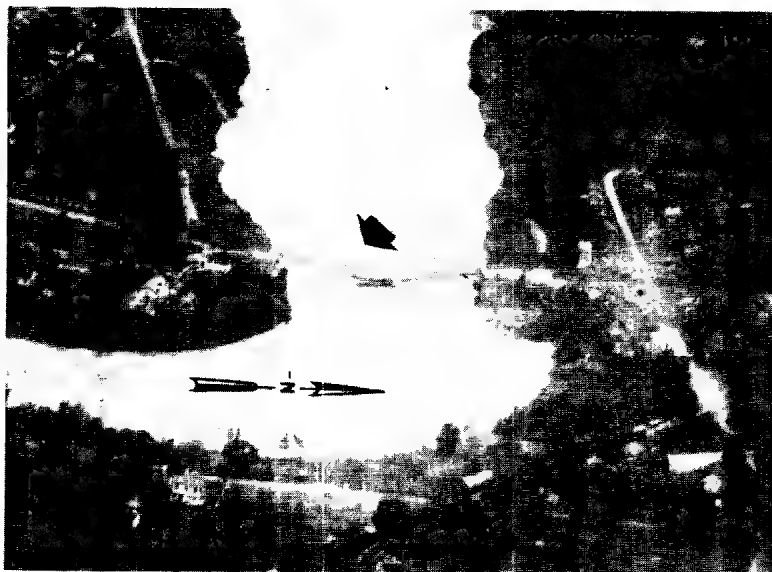


Figure 12. Strike in Early August 1967 Against the Lang Son Railroad and Highway Bridge

This photo shows results of the very successful first strike in early August 1967 against the Lang Son Railroad and Highway Bridge 9 miles south of the China border in northeast North Vietnam. However, there is a system of highway and rail bypasses around this interdicted bridge.

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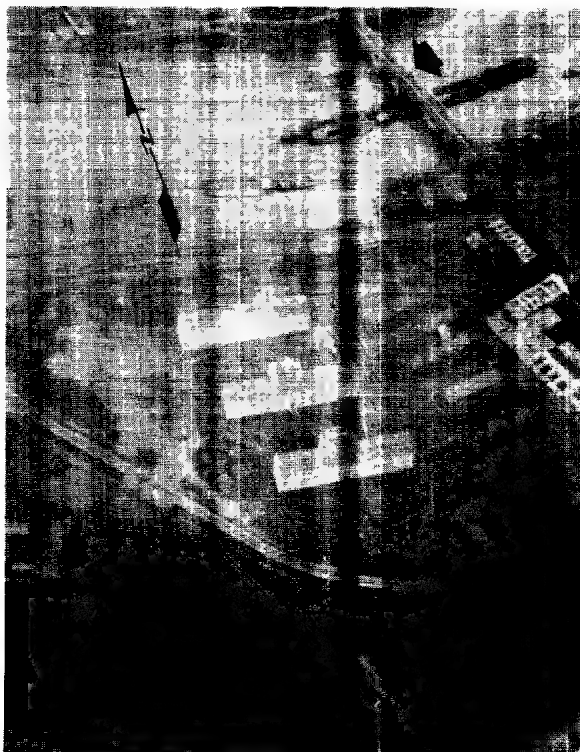


Figure 13. The Haiphong Railroad and Highway Bridge over the Song Tram Bac.

This 2-span steel bridge on the western edge of the city has been reinforced by the installation of additional piers (probably 4 piers) under the spans to reduce the possibility of airstrikes causing the collapse of an entire span. Similar reinforcement has been seen on the Hanoi Rail and Highway Bridge over the Red River (Paul Doumer Bridge).

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since late 1965, the Chinese have also widened the railbed to handle standard-gauge rolling stock and have built additional rail yards and probably assisted elements of the Chinese First Railway Engineering Division in the construction of the 30-mile standard-gauge rail line between Kep and Thai Nguyen. The only unusual Chinese response to increased bombing on this line was noted in radio communications serving Chinese units in northeast North Vietnam on 13 August 1967. The messages passed may reflect Chinese advanced warning of US Rolling Thunder missions against targets in this area.

2. Haiphong Area

Countermeasures on the Haiphong line, contingency planning in Haiphong, and road construction between Haiphong and the Chinese border reflect North Vietnamese preoccupation with the possible destruction of their port facilities in future air attacks. Rail bypasses to the important bridges on the Haiphong line were built to provide "tandem service" with the main bridges. The combination railroad/highway bridge at Ngoc Kuyet, located 35 miles west of Haiphong, was struck in early July, but a bypass bridge had been in place since April. Within Haiphong city, a rail trestle bypass to the Haiphong Railroad/Highway Bridge was under construction in July 1966, and three reinforcing piers were seen under the main bridge in March 1967, although the bridge was not struck until 11 September 1967 (see Figure 13). A water-to-rail transshipment area to handle POL and general cargo has been developed during 1967 and used extensively at Loi Dong, about four miles northwest of the Chamber of Commerce wharves in Haiphong. These facilities undoubtedly relieve some of the pressure on the main rail yard and storage capacity within Haiphong, although cargo must be lightered to this point from the port area.

Road construction, new bridges, and improvements north of Haiphong suggest that additional land transport capacity from China into North Vietnam is being readied for use in case the Haiphong

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port is closed. Aerial photography since November 1966 and more recently in July shows continued construction in North Vietnam and in China of two probable new border crossing roads. Both of these roads were within three miles of being connected as of 20 July. The existence of three border crossing roads plus the key rail line between P'ing-hsiang and Dong Dang makes the two new crossings contingency roads in case Haiphong port is closed.

A new type of bridging technique at three sites on Route 18, a main road linking Kwangsi Province, China, to the Hanoi-Haiphong area, was seen in June 1967. These bridges are built with masonry or concrete causeway sections linked by concrete deck spans over massive masonry or concrete piers. The crossings range in length from 330 feet to more than 700 feet and are very sturdy structures. The three structures are apparently part of a program that has been under way for the past two years to improve Route 18 and its feeder routes and to remove chokepoints from this important coastal network. The massiveness of construction greatly reduces the vulnerability of these "bridges" to bomb damage.

There is also a cable bridge in place at Ha Chanh on Route 18 where the original bridge was interdicted. The cable bridge, another unique bridging technique that is used extensively in North Vietnam, uses steel wire rope stretched taut and anchored on each river bank to provide sub-structure support for the deck of the bridge. The technique is widely used with removable decking to make the bridge appear unserviceable during the day.

3. Kep - Thai Nguyen - Hanoi Rail Line

The Thai Nguyen rail line has taken on new importance for the North Vietnamese during 1967 because, coupled with the completion of the Kep to Thai Nguyen standard-gauge line, it acts as an alternate rail line to that portion of the Dong Dang line between Kep and Yen Vien, located on the

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outskirts of Hanoi. Moreover, the Thai Nguyen line has been converted to handle both meter-gauge and standard-gauge rolling stock, thereby providing through rail service for both gauges. Although bridges on this line have been destroyed by air-strikes, they have been repaired or rail bypasses have been built by elements of the Chinese First Railway Engineering Division. The rail yard at Thai Nguyen, which has been heavily bombed, also continues to be repaired. Construction of a new rail yard and probable storage facilities eight miles south of Thai Nguyen, near Van Duong, has been under way since January. The loop road pattern and the large buildings being constructed at this site suggest that it may have a missile-related function, but no definite answer to the purpose of this activity has been determined.

4. Lao Cai Rail Line

The escalation of bombing on the Dong Dang line may force the North Vietnamese into greater use of the Lao Cai line which connects Hanoi to Yunnan Province, China. Most of the bridges on this line are less than 100 feet long and have been rapidly repaired by Chinese engineering troops without the need for bypass structures. However, the 1,000-foot-long bridge at Viet Tri has not been repaired since it was destroyed in June 1966. Instead, a rail ferry was put into operation.

During the period May to July 1967, new countermeasures were observed along the Lao Cai line. Seven new bypass bridges have been seen under construction, and in late June reconstruction was started on the Viet Tri bridge. A rail bypass at Dai Loi was placed in service by the addition of approach tracks within two days after a strike on the original bridge in August 1967. Earlier in 1967, there was evidence of realignment on portions of the line and a considerable amount of expansion of rail facilities at K'un-ming, the terminus of this rail line in China. In addition, a new dual-gauge rail yard was constructed about seven miles north of Hanoi where the Lao Cai line joins

with the Dong Dang line. This construction together with the new yard northeast of Yen Vien provides additional yard capacity in the Hanoi area for both meter-gauge and standard-gauge rolling stock.

5. Presence of Chinese Engineering Troops South of Hanoi

South of Hanoi the rail line has been kept serviceable, probably by Chinese engineering troops, to Ninh Binh, where road connections from Haiphong and rail and road connections from Hanoi join. A North Vietnamese prisoner reported Chinese troops in the Ninh Binh area during early 1967. This confirms other reports that a Chinese construction unit had moved to the Hanoi area in late 1966. This is the first time since the start of bombing that Chinese engineering troops have been seen south of Hanoi.

C. Countermeasures in the South

1. Route 7

At the same time that key rail lines and roads in the northeast were being kept open, other main LOC's that connect North Vietnam to Laos and the DMZ have been kept serviceable. Route 7, the main highway for supporting Communist forces in the Plain of Jars in Laos, was heavily bombed early in the Rolling Thunder program, with a total of 25 bridges being completely destroyed. Initially, the North Vietnamese were forced to rely mainly on natural fords to keep traffic moving on this important route. During the past two years, however, they have built 17 alternate bridges and constructed 20 fords to bypass the 25 destroyed bridges. Recent photography indicates that Route 7 is heavily used in spite of continuing attacks and that numerous storage facilities and truck parks are dispersed along its entire length.

2. Route 137

Another sophisticated means of hardening LOC's in North Vietnam has been the construction of roads through terrain that affords concealment from

aerial view and which contain almost no chokepoints. Route 137, which was constructed in the spring of 1966 as an alternate border crossing road to heavily bombed Route 15 (the road through Mu Gia Pass), is a good example of this. The road is 57 miles long, including the stretch in Laos. Constructed or modified rock-fill fords were used at two stream crossings. No bridges were identified along the route, and the only chokepoint that has appeared since the route was first bombed is at a stream crossing in Laos. This road also has numerous storage facilities and truck parks along its entire distance.

VII. Prospects for the Interdiction Campaign

Our analysis of the intensified interdiction campaign against lines of communication, particularly the vital rail lines in the areas of Route Packages V and VI, indicates that the campaign has not attained any meaningful reduction in North Vietnam's logistic capabilities. Although the repeated attacks against key targets on all of the major rail lines in North Vietnam have seriously disrupted transport operations, there is convincing evidence that the military and economic goods needed to support the war in both North and South Vietnam have continued to move. Damage to LOC's from air attacks continues to be quickly repaired, while effective alternates and improvised facilities are employed to maintain traffic.

The inability of the airstrikes to cause severe and sustained damage to the transport sector or to restrict significantly the flow of supplies results from several factors:

The North Vietnamese, with the help of Chinese construction troops, are continuing to develop effective counter-measures to the US air attacks. The main LOC's continue to be hardened and more alternative routes and improvised facilities for the movement of traffic are being developed. In addition, much of the anticipated impact of air attacks was effectively canceled out by the execution of contingency measures long before the attacks started.

The tonnages that move over the North Vietnamese transport system are small compared to the overall capacity of the system. Moreover, the excess of capacity over traffic requirements has increased. In the northern areas, particularly, the North Vietnamese have a flexible rail, highway, and water system with a great deal of built-in redundancy.

Despite a fivefold increase in the weight of the attacks against the northern lines during recent months, it has proven difficult to damage severely many LOC targets located in heavily defended areas. Railyards and rail cuts have been easily repaired. Destroyed or partially destroyed bridges have either been repaired quickly or replaced by ferries, fords, or pontoon or more permanent bypass bridges. Thousands of trucks and large numbers of railroad rolling stock have been destroyed, but imports have made up the losses. Imports and domestic production are alleviating the large losses of water craft. In the north most of the serious damage to the railroads is probably being repaired by the professional Chinese construction (and air defense) troops numbering 30,000 to 50,000.

Even a greater intensification of the air campaign against LOC's in the North would fail to disrupt transport to such an extent that North Vietnam would be unable to receive its essential military and economic supplies. There is no evidence that the added costs and increasing logistics burden inflicted by these campaigns add sufficiently to Hanoi's problems to cause it to reconsider its resolve to continue with the war. The experience of the past few months makes the prospect particularly dim that a land-oriented interdiction campaign would reduce the flow of seaborne imports or deny sea access to North Vietnam. New weapons offer the promise of more effective interdiction programs. But on the basis of its impressive performance thus far, the possibility of North Vietnam's developing effective counter-measures can not be discounted.

The maximum yield to be expected from an interdiction campaign -- political considerations aside -- would result from a program that combines interdiction of land and water routes. This program would include the mining of the water approaches to North Vietnam's major ports and the bombing of ports and transshipment facilities. This program would maximize the hardships imposed on North Vietnam and

increase the costs of its support of the war in the South. It would, however, not be able to cut off the flow of essential supplies and, by itself, would not be the determining factor in shaping Hanoi's outlook toward the war.

Appendix

Photographic Evidence of Railroad Operations During June-August 1967

Aerial photography obtained on ten days during the period 20 June through 31 August has been examined in an attempt to determine the extent of railroad operations during a period of heavy air attacks against the railroads. Although some photography is available on all of the railroad lines in North Vietnam, a complete analysis of rail operations has been impossible because of gaps in coverage, the different dates of available photography, cloud cover, and the difficulty of interpreting poor-quality obliques.

Reasonably comprehensive coverage was obtained on only two of the ten days: 20 June and 19 July. On these dates a total of 1,429 and 1,373 cars were sighted, respectively. The photography of 20 June showed 16 freight trains; photography of 19 July detected four trains. On 21 August, photography showed a total of 1,305 cars on the Hanoi - Dong Dang, Hanoi-Haiphong, and Hanoi - Lao Cai lines alone.

On six of the ten days, partial photographic coverage of the Hanoi - Dong Dang line showed the following equipment:

<u>Railroad Cars</u>				
<u>Date</u>	<u>Trains</u>	<u>In Trains</u>	<u>In Yards</u>	<u>Total</u>
20 June	7	209	211	420
19 July			385	385
20 July	4	138	614	752
21 August	3	42	738	780
29 August			96	96
30 August			275	275

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This line showed the highest concentration of cars of any line covered, and it is significant that the highest number of serviceable cars on this line occurred on 21 August, several months after the line had been taken under heavy attack. It is also significant that on this date, 200 of the cars sighted were in the Hanoi area and 300 north of Cao Nung in the buffer zone next to China, indicating an attempt to retain the cars in "sanctuary" areas during daylight with train operations taking place principally at night. The sample of trains does not lend itself to traffic analysis, but the number of cars present on this line on the dates of good coverage indicates that the North Vietnamese retain a considerable potential for the movement of freight.

Photography revealed the second highest concentration of cars on the Hanoi - Lao Cai line, as follows:

<u>Date</u>	<u>Trains</u>	<u>Railroad Cars</u>		
		<u>In Trains</u>	<u>In Yards</u>	<u>Total</u>
20 June	4	61	359	420
19 July	2	38	276	314
20 July			47	47
21 August			320	320
31 August	1	17	29	46

The Hanoi-Haiphong line was photographed partially on six of the ten days, and concentration of cars on this line ranked third as follows:

<u>Date</u>	<u>Trains</u>	<u>Railroad Cars</u>		
		<u>In Trains</u>	<u>In Yards</u>	<u>Total</u>
20 June	4	61	207	268
19 July	1	30	17	47
21 July			82	82
28 July			30	30
21 August	1	13	192	205
23 August			40	40

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The Hanoi-Vinh line was photographed on only two days, but the quality of the photography was so poor that activity between Thanh Hoa and Vinh could not be determined. On the dates covered, however, this line had a higher concentration of cars than the Hanoi - Thai Nguyen and Kep - Thai Nguyen lines. On 20 June, 213 cars were observed between Hanoi and Thanh Hoa, of which 13 were in a train. About 100 of these cars were noted in the Thanh Hoa region, which serves as the transloading point from conventional to modified rolling stock. (Lightweight meter-gauge rolling stock is used to overcome impaired track conditions and limited bridge capacities south of Thanh Hoa.) On 19 July, 333 cars were sighted at various points along the line, but no large concentrations were noted and Thanh Hoa was not included in the photography. One train consisting of ten additional cars was identified.

The Hanoi - Thai Nguyen line was observed on 20 June, 19 July, and 20 July. Cars in yards numbered 31, 268, and 261 on these dates, respectively. One train consisting of 27 cars was sighted on 20 July. The Kep - Thai Nguyen line was also observed on the same dates with cars in yards numbering 77, 16, and 34, respectively. A 27-car train was observed on 20 July, and 28 cars were sighted in yards on 30 August.

Obviously, many of the car counts on the various lines are not representative, because of incomplete photographic coverage. By eliminating those counts which are least representative and by averaging the days of the more representative car counts on the various lines during the period 20 June through 31 August 1967, we arrive at the following:

<u>Railroad Line</u>	<u>Average Cars Per Day</u>
Hanoi - Dong Dang	584
Hanoi - Haiphong	236
Hanoi - Lao Cai	351
Hanoi-Vinh	278
Hanoi - Thai Nguyen	280
Kep - Thai Nguyen	69
Total	<u>1,798</u>

If all cars except those on the Kep - Thai Nguyen line are assumed to be meter-gauge cars (capable of an average net load of 15 tons) and all cars on the Kep - Thai Nguyen line are assumed to be standard-gauge cars (capable of an average net load of 30 tons), the average of 1,798 cars sighted could carry 28,000 tons. The current average turnaround time for freight cars probably is about three days. Thus 9,300 tons could be originated daily by using the cars sighted, an amount very close to the 9,000 tons per day estimated to have originated on North Vietnamese railroads during 1966. There is, however, an estimated total of from 2,000 to 2,300 freight cars available in North Vietnam,* of which undoubtedly more than 69 are standard-gauge cars. This total would provide more than ample capacity to move North Vietnam's current railroad requirements for domestic and international freight.

* Derived by extrapolating the number of cars sighted to include estimates for those portions of the rail network not covered by photography.

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